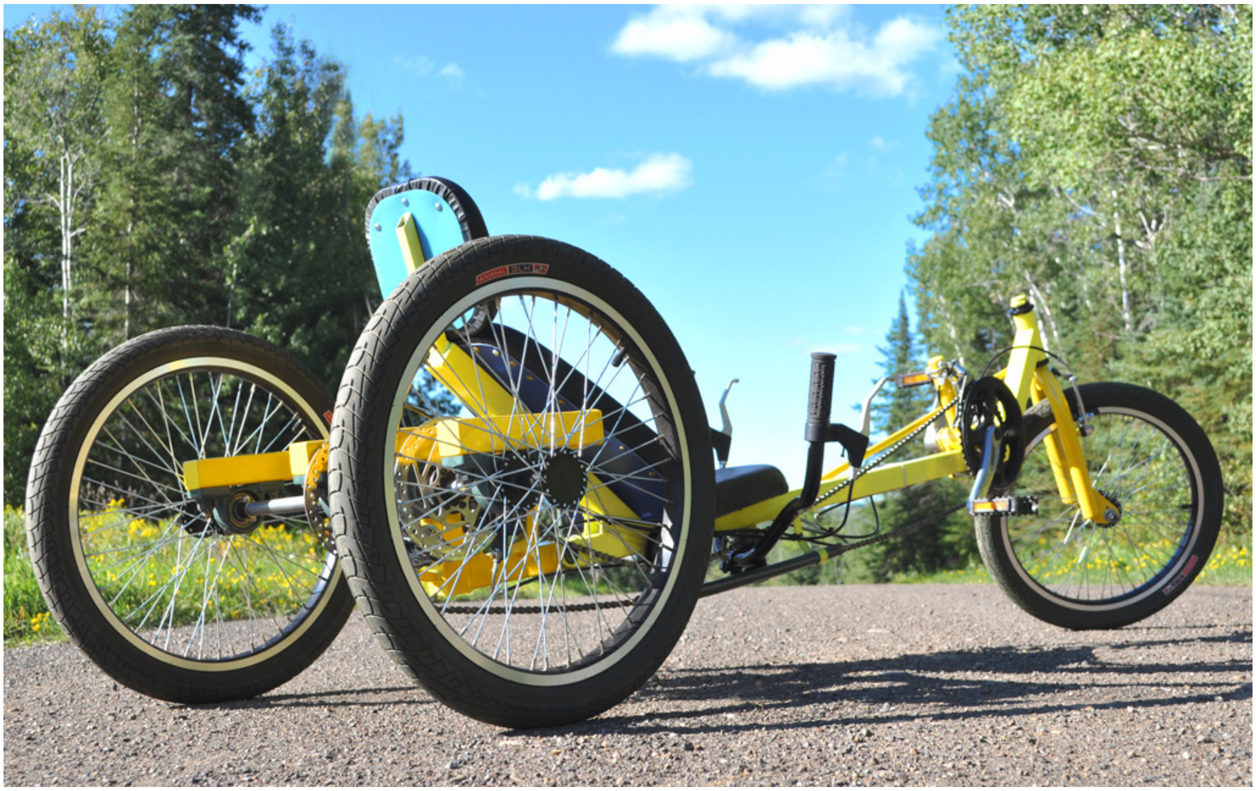
AURORA DELTA RACING TRIKE



The Aurora Racing Delta Trike is a low and laid back recumbent trike will perform equally well on both the road and the trail. The low center of gravity allows the Aurora to race into corners at full speed, hugging the road like a performance race car while you keep on pedaling. Under seat steering offers complete control over the handling at any speed and places your arms in a comfortable and relaxed position. For the rugged terrain, the Aurora is equipped with rear suspension and a low climbing gear range that will smooth out the ride and allow you to beat hills of any size with ease.

Typically, high performance trikes have been of the tadpole type (two wheels in the front), but the Aurora shatters this stereotype with its ultra low seating position and corning abilities. You can build your own racing delta trike using mostly standard bicycle components and steel tubing, and you can do so at a fraction of the cost of an equivalent factory produced trike.

Please read the entire plan at least once before making any cuts or sourcing any components, as you may want to make modifications along the way, and some of the measurements will be based on your size requirements. Feel free to add your own modifications to the plan, but remember to look ahead so you can understand what adjustments will need to be made.

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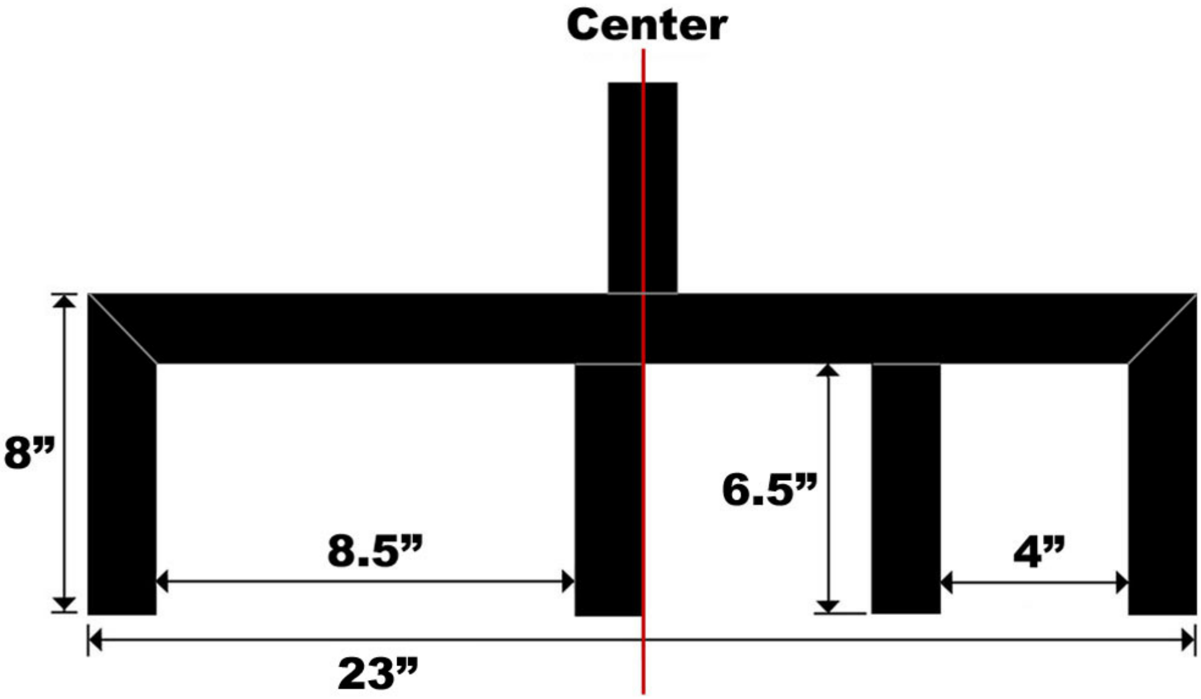
THE REAR FRAME



Drawing 1 - The rear frame dimensions

Most of the Aurora frame is made using 1.5 inch mild steel square tubing with a 1/16 inch wall thickness. This tubing can be ordered from any steel supplier and is very easy to cut and weld. Steel suppliers like to rate tubing wall thickness using a gage number, so 1/16 wall tubing will be called “16 gage tubing”, and although there is a slight difference between the two, your best bet is to tell them you want a length of 1.5 inch square tubing with a wall thickness as close to .0625 inch (1/16) as you can get. If you are a heavy rider (over 280 pounds), then you should ask for the next size after that, which will likely be 14 gage tubing, or .078 inch wall tubing. Round tubing should be avoided for this project, as it will be much more difficult to weld and create problems with the adjustable bottom bracket.

Drawing 1 shows the tubing sections that will make up the rear of the Aurora frame. This part of the frame supports the rear axles, transmission components and disc brake hardware and it is also acts as a rear suspension swing arm. The cuts are all simple 90 degree or 45 degree cuts, so you can make them by using a chop saw or by marking them with a 45 degree square for cutting with a hacksaw or zip disc. You can make the track width wider if you want to by altering the 23 inch dimension, but take note that the 8.5 inch dimension will also have to change as the tube that is just under the center line has to be to the left of this center line as shown in the drawing. Making your trike wider is only necessary if you intend to carry specific cargo box or are fitting the trike into a pre-existing fairing.

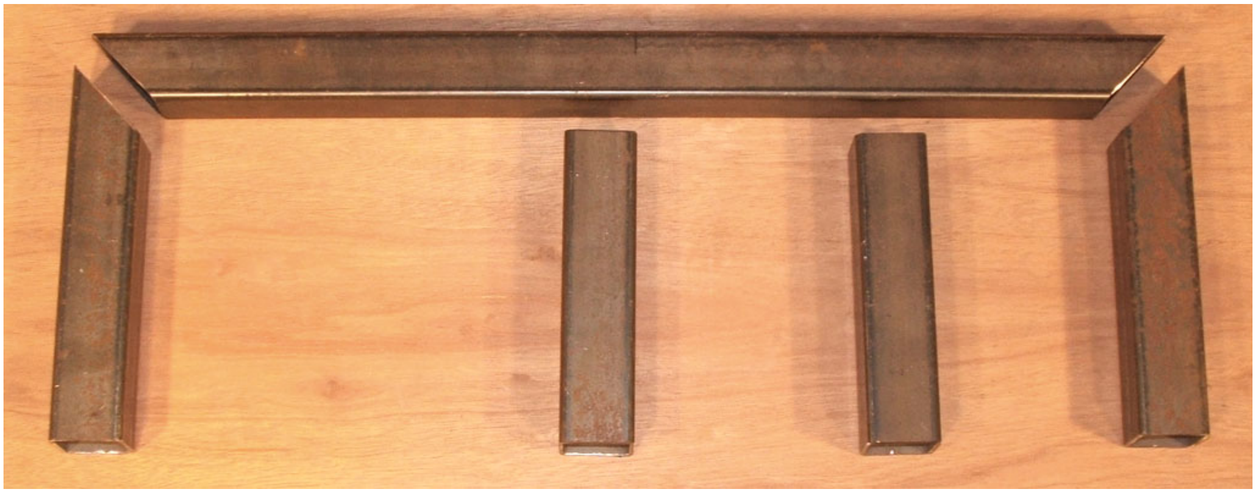


Figure 1 - Cutting the rear frame tubing

The five rear frame tubes are cut and laid out in their basic shape as shown in Figure 1. As for names, I will refer to the tubes as follows: the long horizontal tube will be called the “rear T tube” and the four shorter horizontal tubes will be called the “axle support tubes”. Notice that the rear T tube and two end axle support tubes are cut into a 45 degree joint. This type of joint closes the tubing completely so there is no open end to worry about. The two center tubes are cut straight across with a total length of 6.5 so that all 4 tubes measure a total of 8 inches from the front face of the rear T tube.

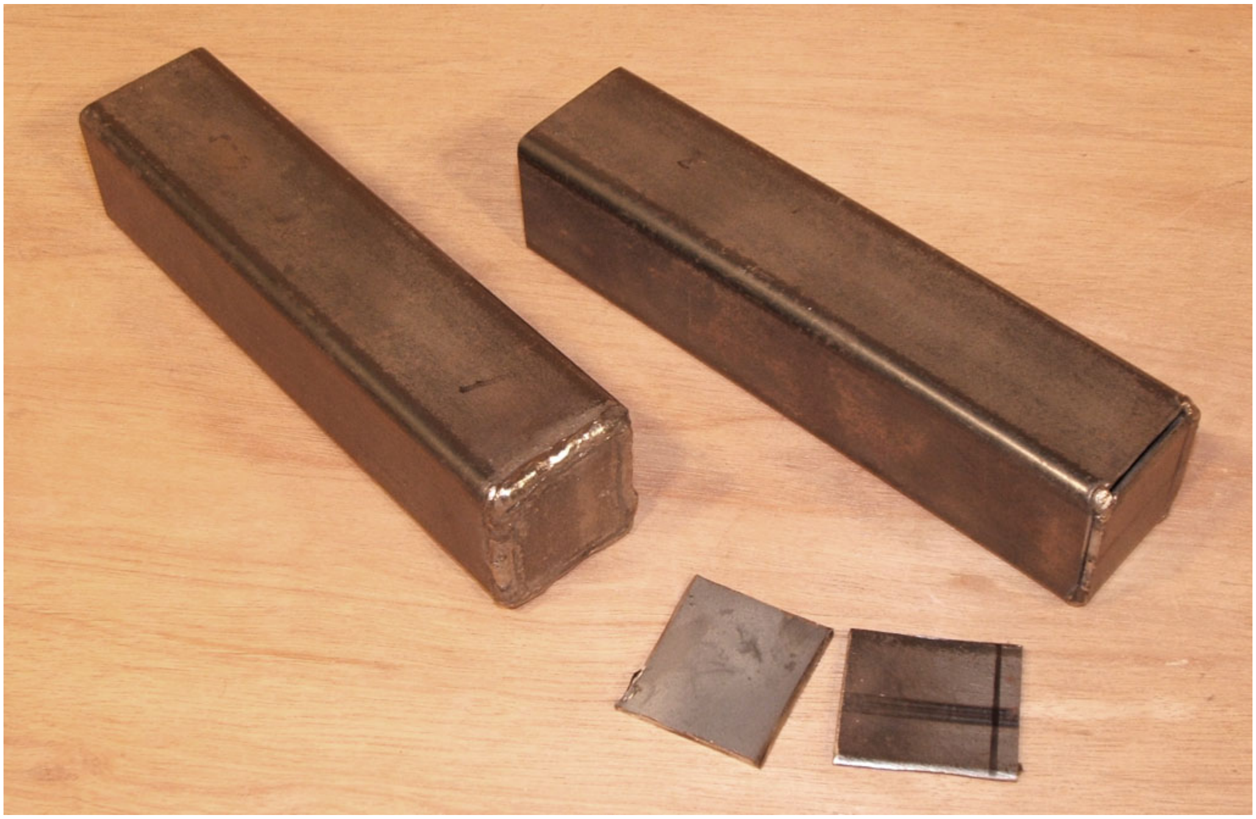


Figure 2 - Capping the open ends of the tubes

Caps for the open tubing ends can be made by cutting a few 1.5 inch square pieces from some leftover tubing wall or sheet metal. There are plastic plugs that you can get to cap off the tubing, but those will not enhance the strength of the tubing. This is important since the pillow block bearings will be held very close to the open ends of the axle mounting tubes. Without the steel caps welded in place, the force of the bearing base may collapse the end of the tube if the shock from the rear wheels was great enough.

Figure 2 shows the end caps made by cutting some left over tubing into 1.5 inch squares. The sheet metal or scrap tubing should be as close to the thickness of the tubing wall as you can find, so 16 gauge sheet metal or pieces of the square tube used for the frame will fit the bill perfectly. Cut the squares any way you like. My favorite method is to run a cut-off disc along the marker lines then bend the parts back and forth until they snap apart. The caps should be welded in place before any other welding is done so that it will be easy to work with the small parts on the workbench when you are cleaning up the welds with a grinder.

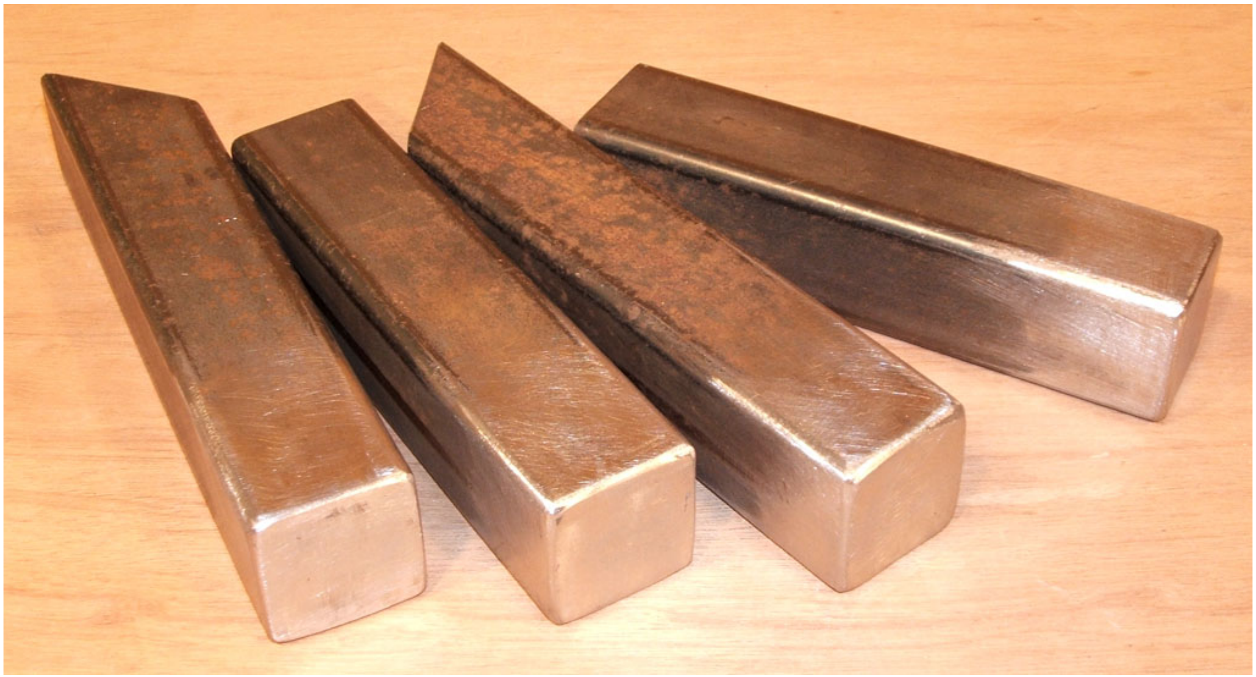


Figure 3 - Cleaning up the end caps

After welding all the way around each end cap joints, grind the weld metal using a rough grinder disc, making sure not to take away any of the original tubing metal. To make the end cap look perfect like the ones in Figure 3, carefully clean up the welded area using a sanding disc (flap disc) until the joint is flush with all sides of the tubing. You may have to fill in the odd pinhole and run the grinder over the area a few times to get the corners perfect, but it is definitely worth the effort, and will enhance the look of your final product.

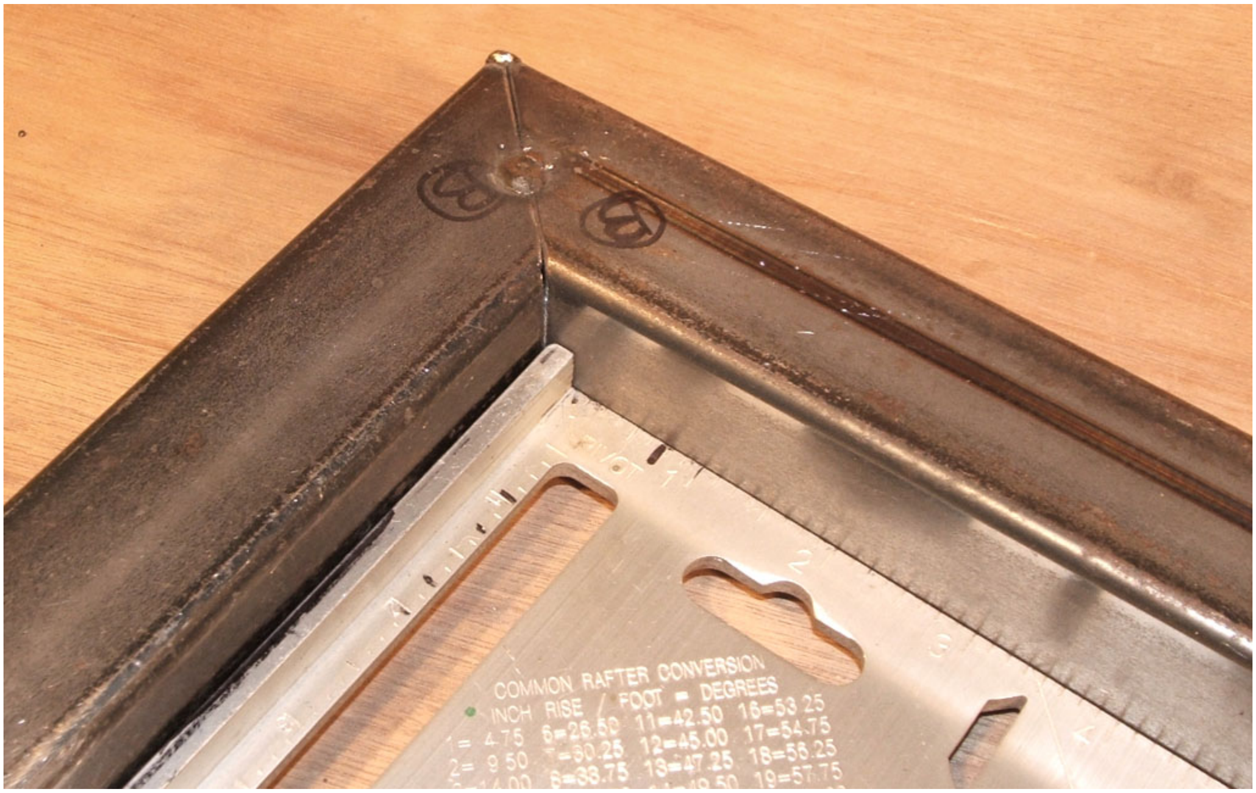


Figure 4 - Tack welding the 45 degree end joints

Weld the two outer axle mounting tubes to each end of the rear T tube as shown in Figure 4. With the two 45 degree angles welded together, the two parts should form a perfect 90 degree angle. The best way to get the angle as close as possible is by placing the tubing on a very flat surface and aligning the two parts with a 90 degree square. Tack weld a spot on the top of the joint then re-check the 90 degree angle with your square. If the angle looks good, add two more tack welds at each corner of the top of the joint, and then repeat the process for the other axle mounting tube at the other end of the rear tube.

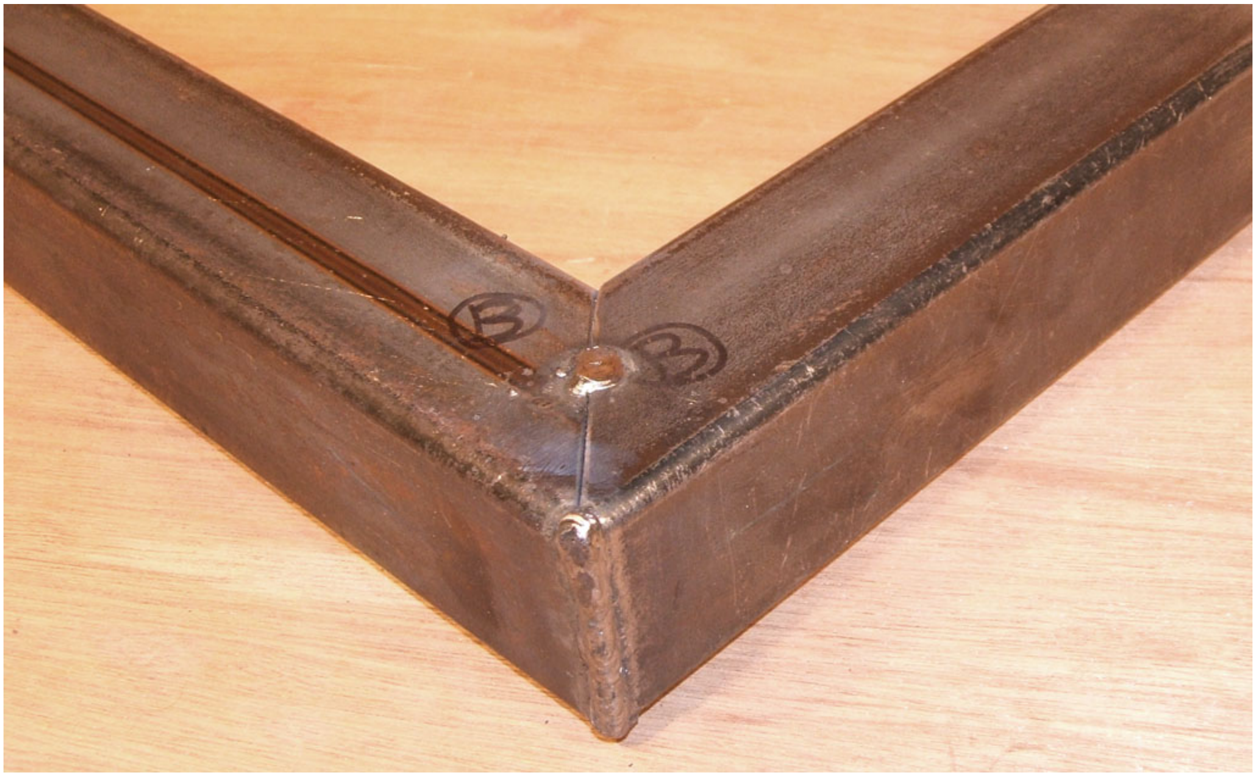


Figure 5 - Weld the corner of the joint first

Once the top and bottom of the 45 degree joint are tack welded, run a bead of weld along the outer corner as shown in Figure 5. Because the outside corner joint adds almost no tension due to heat distortion, the 90 degree corner should still be perfect. Order of welds is always something that should concern a good welder. Once you understand heat distortion, you can minimize it, and even use it to your advantage.

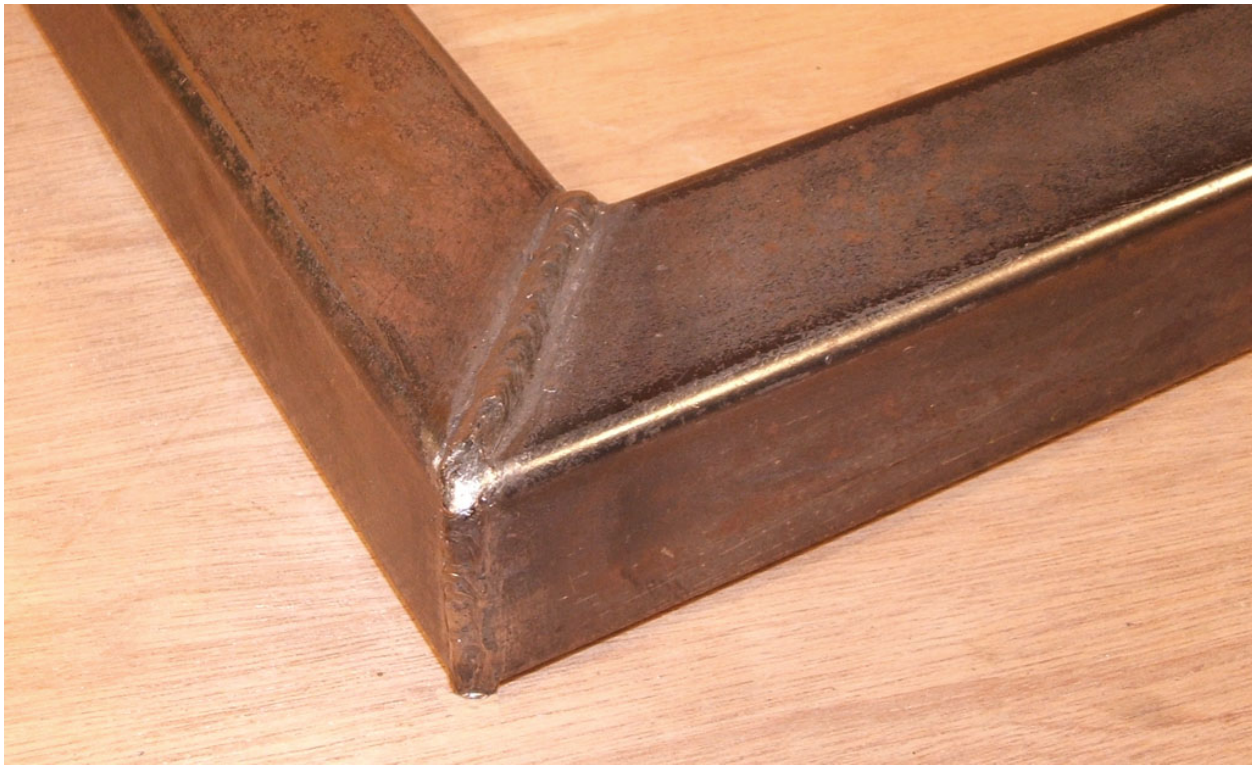


Figure 6 - Completing the top of the joint

Once you have completed the outer corner welds, let the work cool and then weld the joint along the top of the tubes as shown in Figure 6. Let the work cool once more and then flip the tubing over again to complete the welding along the other side of the joint. A little less heat may be necessary here as a burn through is likely to occur along the face of a square tube joint, rather than on a corner joint.

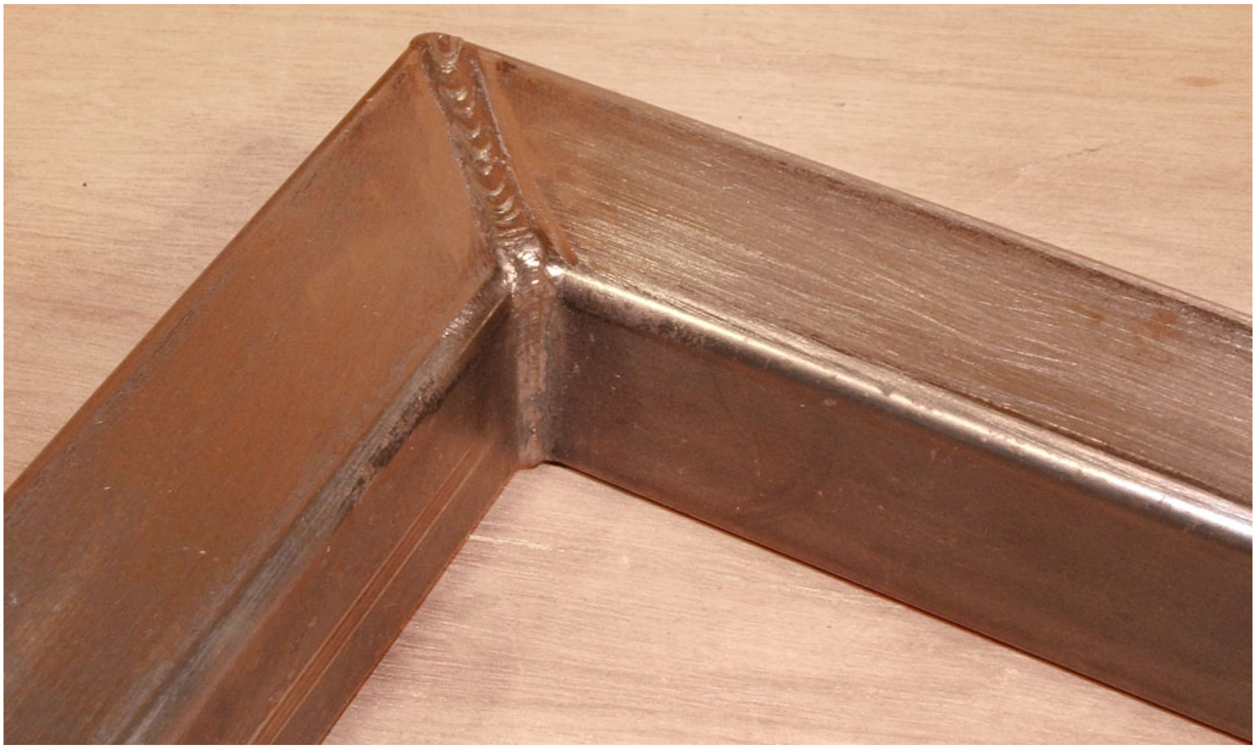


Figure 7 - Completing the inside corner of the joint

The last joint to be completed is always the joint that will have the most effect on the alignment of the final product. As shown in Figure 7, the inside joint is finished last using a smaller bead of weld to keep distortion to a minimum. If you were to start on this joint first, the two tubes would tend to pull together, closing up the desired 90 degree angle by a few degrees. By completing this joint last, the distortion is kept to a minimum due to the other welds holding the two tubes in place. Again, a little distortion is acceptable, and the design takes this into account later on.

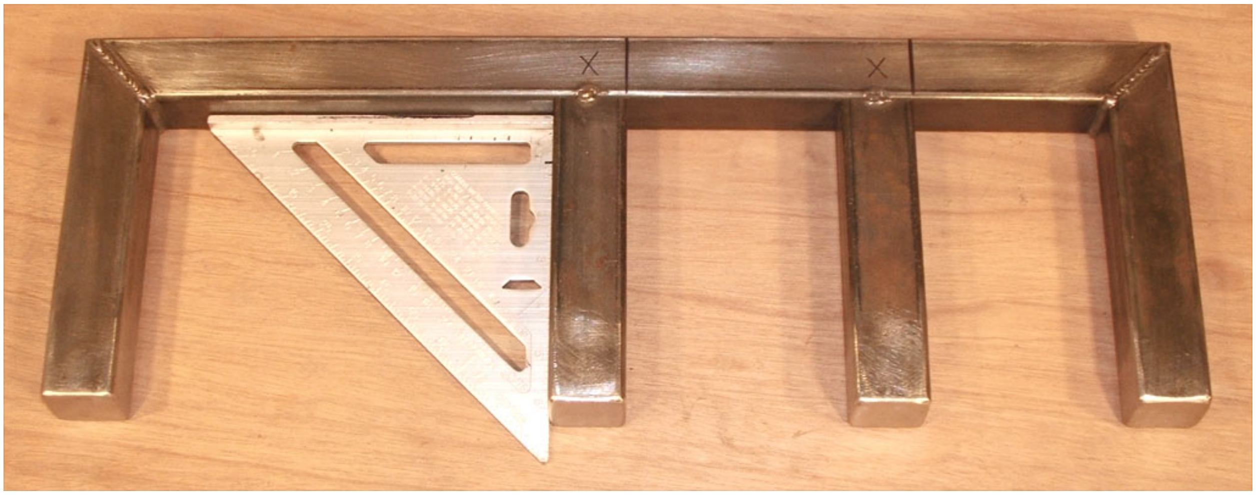


Figure 8 - Installing the inner axle support tubes

The Aurora Trike is driven by a freewheel installed on the left side axle, and brake using a pair of disc brakes installed on both axles. For this reason, the drive side axle support tube needs to be placed on the left side of the center line (refer to Drawing 1). As you can see in Figure 8, I made a marker line on the main rear frame tube at the exact center, and then placed the tube directly to the left of this line, making sure that it was at 90 degrees to the main rear T tube before tack welding. Since the multi-speed freewheel will be connected directly to the end of the left side axle, this places the freewheel in a perfect place for alignment with the front drive chain ring on the crank set; in other words, it creates a transmission much like that on any normal bicycle.

The reason the left wheel is chosen as the drive wheel is because all freewheels have the ratchet set up to engage in the clockwise rotation and to ratchet in the counter-clockwise rotation. Driving both wheels is an even more complex task requiring a special differential which would greatly increase both the weight and cost of this project, yet add no real benefit. Most delta trikes and quadcycles only drive the left rear wheel, and this is completely unnoticeable by the rider while riding under normal conditions.

On upright "granny style" delta trikes and quads, there is a tendency to have the drive wheels slip a little bit when accelerating around a left hand turn, since the high center of gravity will make the left wheel try to lift away from the road. However, since those shopping trikes are not built for any real speed, this is not a real problem. On the Aurora, the rider is placed so low that the center of gravity is such that a wheel lift is almost impossible under all but the most extreme circumstances, and drive wheel slipping is not an issue at all.

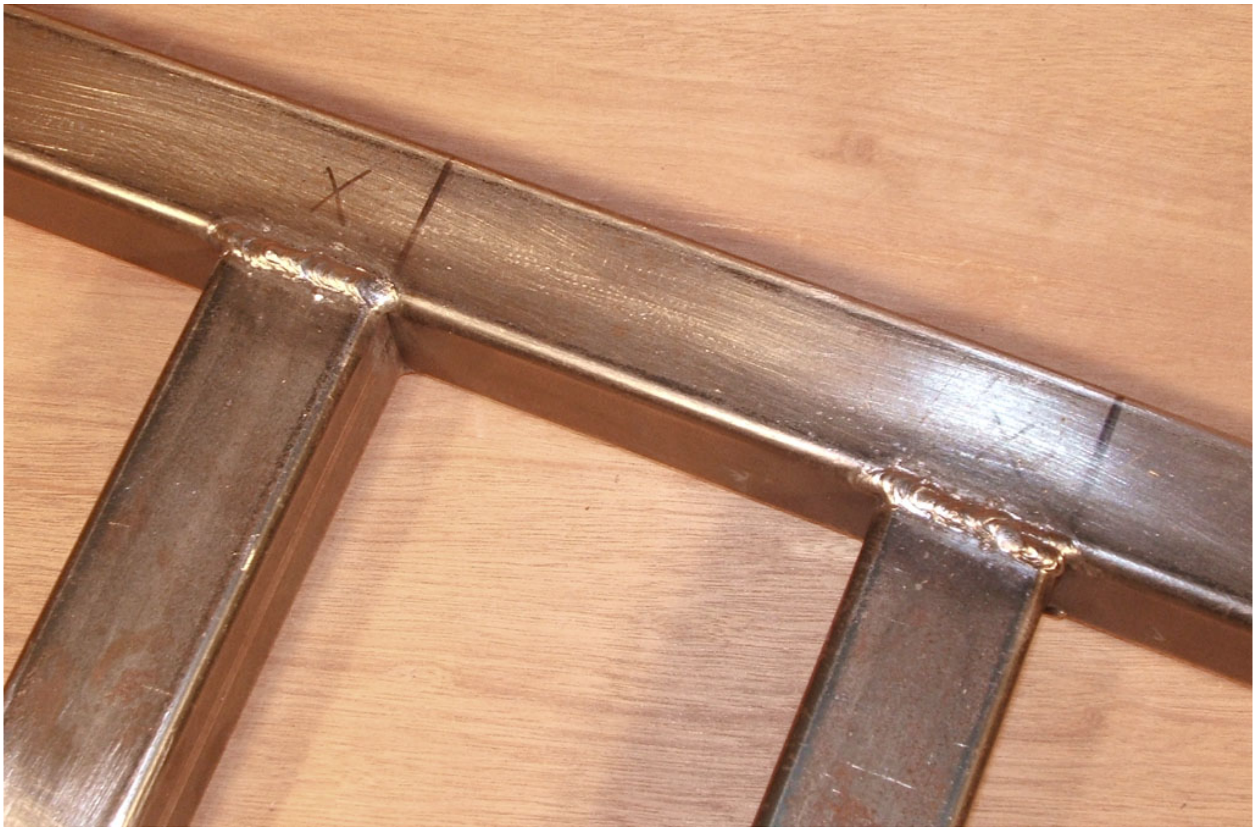


Figure 9 - Following the proper order of welding

The two inner axle support tubes are welded in the respective positions as per Drawing 1 using the same order of welding used on the outer tubes. The top and bottom of the joint are welded, followed by the inside corners. Try to keep the 90 degree angle between tubes as close as possible, and ensure that all four axle support tubes are parallel to each other. It might help to lay or clamp the axle support tubes along a few lengths of straight square tubing or angle iron so they all lined up while you are welding them in position. Figure 9 shows the top welding on the inner axle support tubes completed.

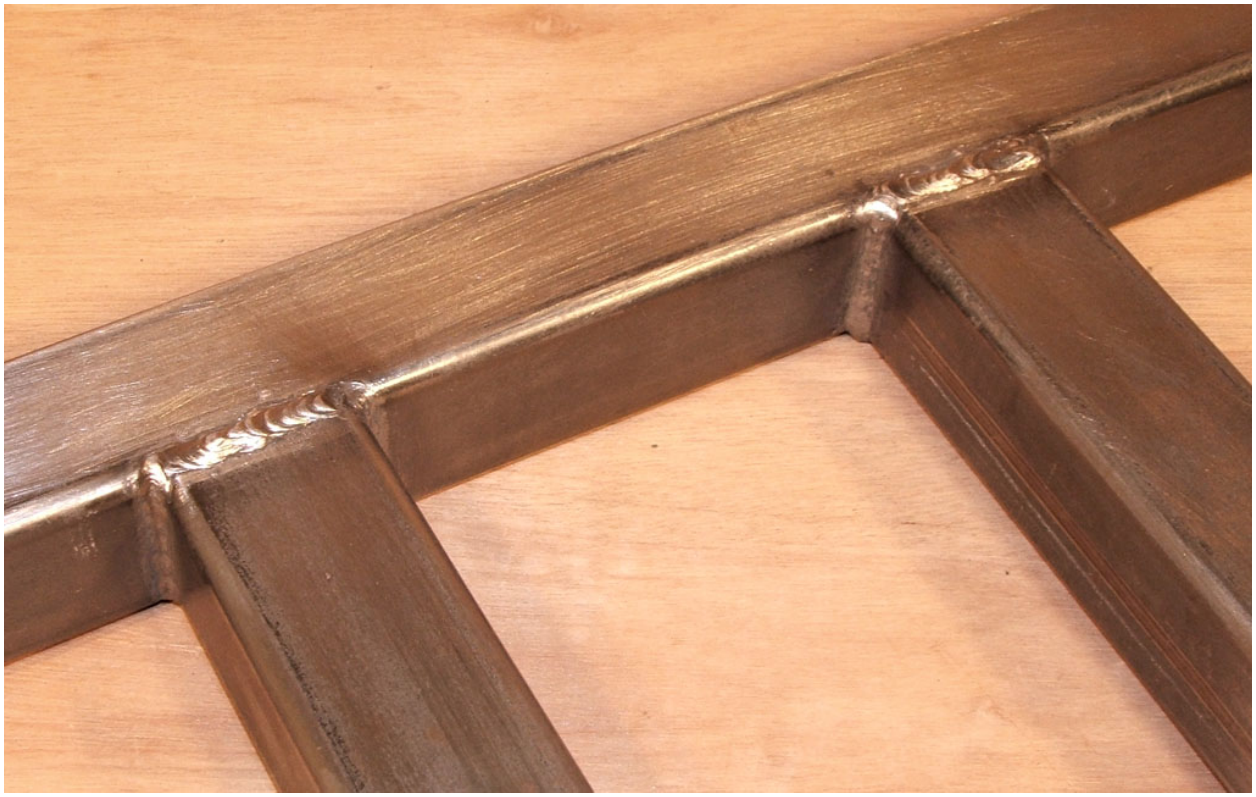


Figure 10 - Rear frame welding completed

Figure 10 shows the completed rear frame after finishing the inside corner welds on the two inner axle support tubes. Your axle support tubes should make a 90 degree angle with the rear T tube, and all four of them should be parallel to each other. You may also notice that the rear T tube now has a slight bow due to heat distortion caused by welding the four axle support tubes. The bowing should be very slight, but you can see it by placing the rear T tube against a known flat surface (axle support tubes facing upwards). Do not worry about this slight bowing, as the design account for this and will ensure that both rear axles align properly.

THE REAR WHEELS

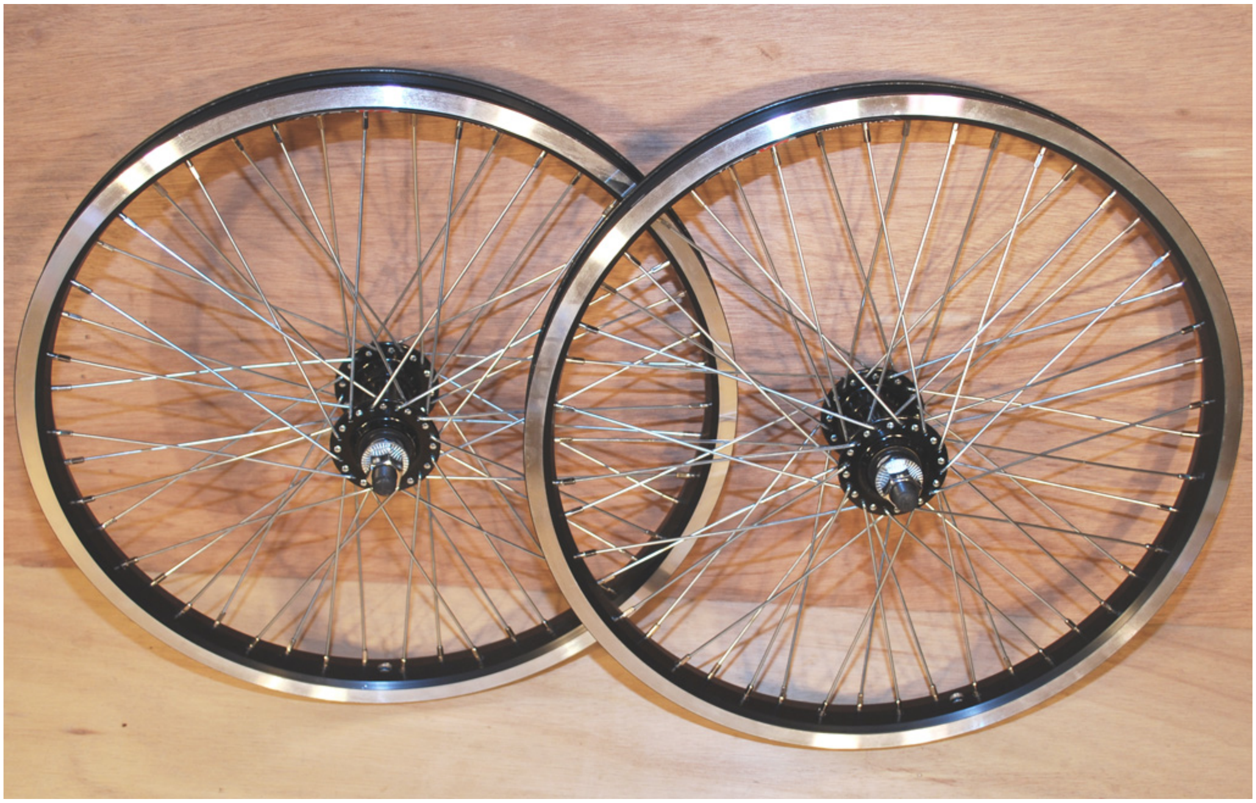


Figure 11 - Choosing your wheels

Builders Tip

The rear wheels on the Aurora Trike are 20 inch rims with either 48 or 36 spokes. If you weigh more than 180 pounds or intend to ride with cargo or a motor assist, then chose the 48 spoke rims. You will need a total of 3 wheels, all with 20 inch rims to complete the trike. The 48 hole BMX rims shown in Figure 11 are fairly common and inexpensive bike store items, so it is practical to purchase 3 of them all new and all the same. You only need front rims for this project!

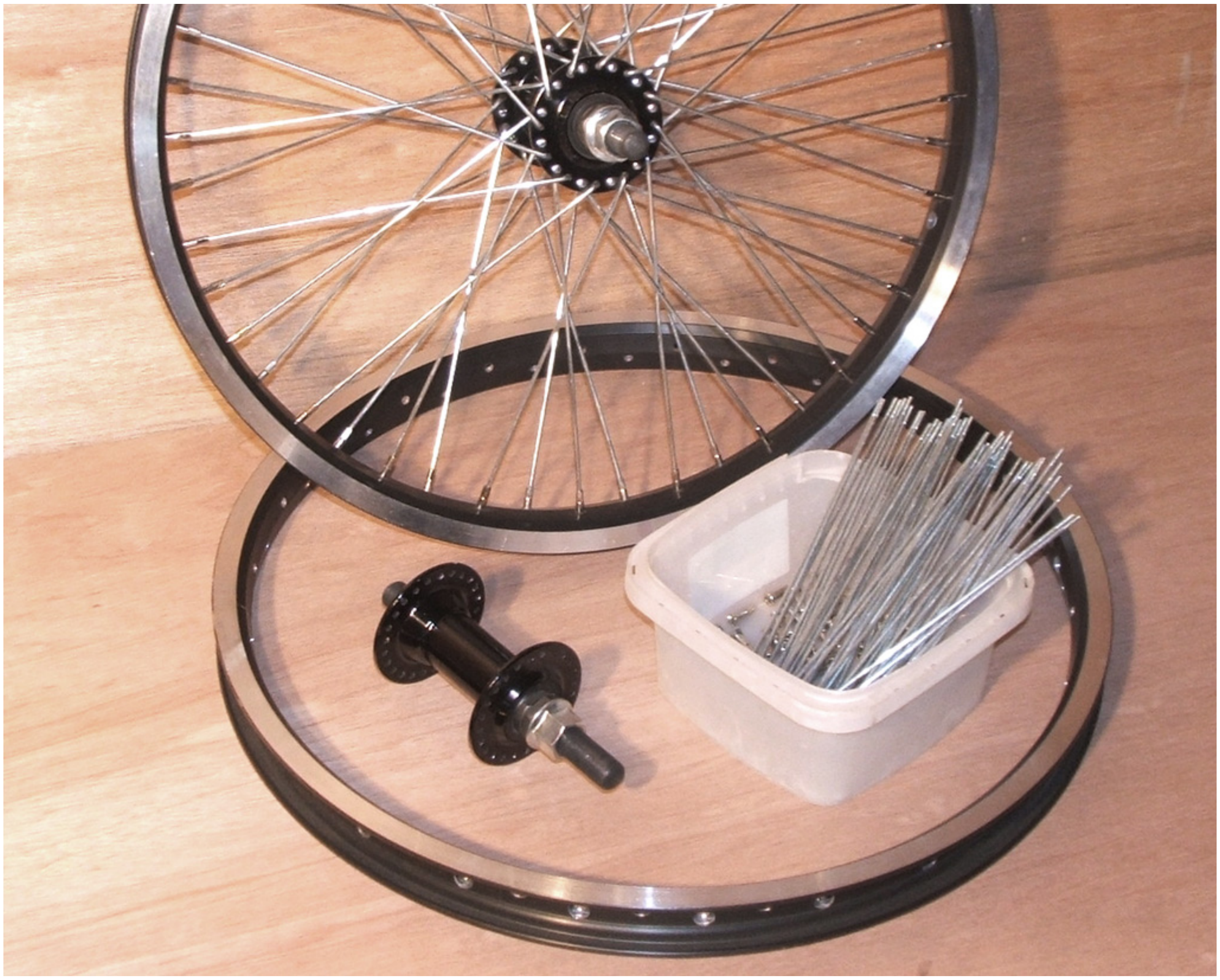


Figure 12 - Remove the spokes from the rims

The rear wheels on the Aurora Trike are unique as they do not use bicycle hubs, so you will need to remove all of the spokes on the two wheels that you plan to use for the rear pair. I chose to use the same 48 hole BMX rims (Figure 12) for both the back and front of my trike so they would all match. Although you will not require two of the three included hubs, it is cost effective to purchase three identical wheels and then remove the spokes and hubs from the rear set in order to build the rear wheels rather than trying to source the rims and spokes separately. These 48 spoke 20 inch wheels are commonly used on freestyle BMX bikes and can be purchased at just about any bicycle shop for approximately $40 per wheel. The complete wheel is cheaper than the rim and spokes due to the magic of mass production.

Remove all of your spokes from the rear pair of rims by turning each spoke nipple counter-clockwise 1 full turn, working your way around the rim starting and ending at the valve stem hole. Keep repeating this process until the spoke nipples are loose enough to be turned all the way out by hand. Removing spokes this way ensures that the rim is not warped during the process.

REAR HUB FLANGES

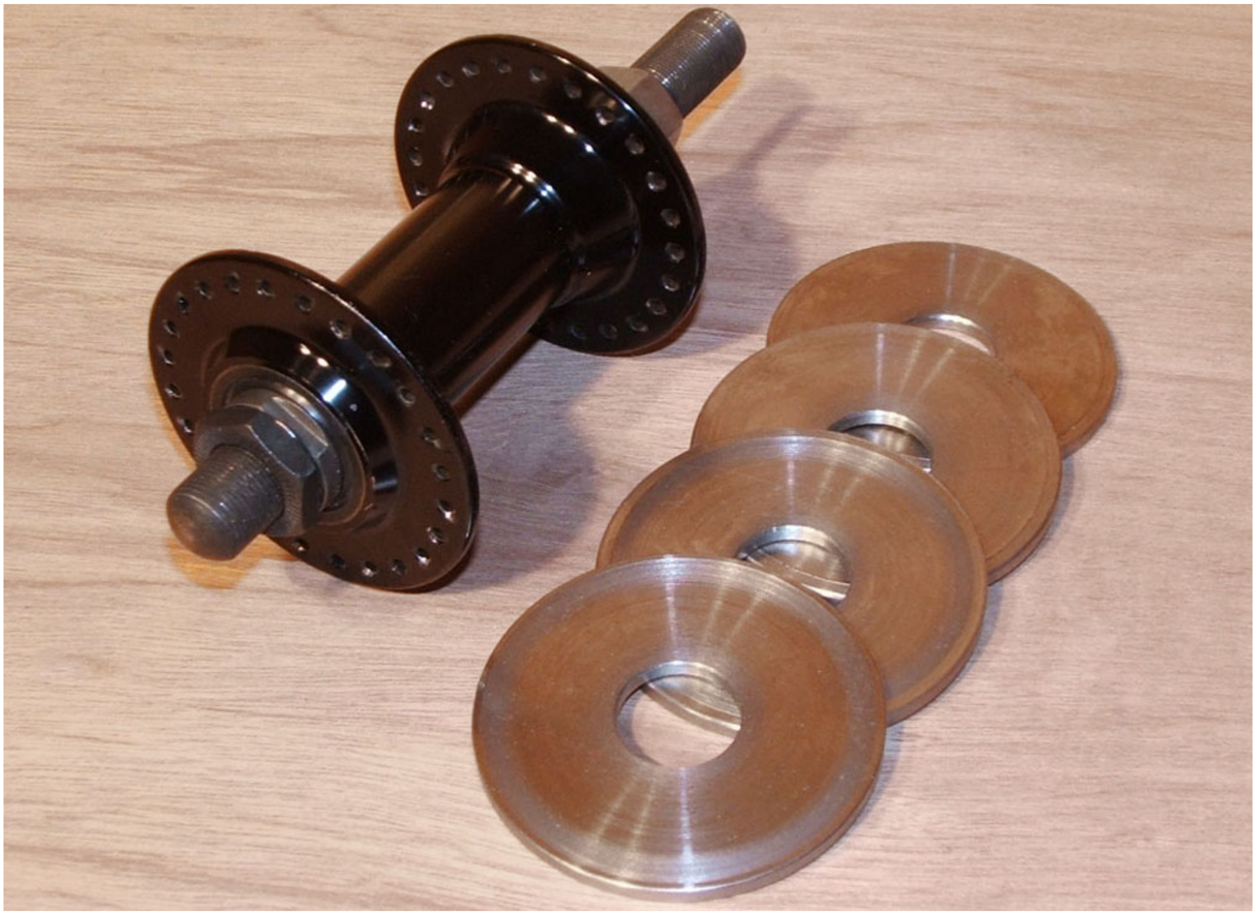


Figure 13 Undrilled rear hub flanges

One of the most unique features of most AtomicZombie delta trikes and quad cycles is that they have no rear hubs. The flanges that hold the spokes are actually part of the rear axles, so this greatly simplifies and strengthens the final design since there will be no need to retro fit the aluminum hub to the steel axle. It would be expensive to drill or machine a bicycle hub and then find some way to secure it to the axle. Only the flanges are needed to hold the spokes to the axle, and although they are made from steel, they are still lighter than a complete aluminum bicycle hub machined and fit to the axle.

As shown in Figure 13 the four hub flanges (two per wheel) are machined by cutting a 1/8 inch thick slice from some 2.5 inch diameter steel stock and then by drilling a ¾ inch hole in the center. The flanges are made with a 2.5 inch diameter because this is the diameter of the original flanges on the hubs that were removed from the wheels. Keeping the new flanges the same width and distance apart will ensure that your spokes fit perfectly back into the rims and hub flanges when laced back up.

Although the four flanges only cost me $50 to have done at the machine shop, you could actually do this part without any machined parts at all if you can source out the exact diameter and thickness washers that you need. Another option is to purchase two hole saws for your drill - one for the outer diameter and one for the 3/4 inch center hole. Keep in mind that you should not exceed the 1/8 thickness when making the hub flanges or you will have a very difficult time getting the spokes to go through the holes and then make the 90 degree angle towards the rim. If you choose the washer route over the machined disc route, you may end up having to get them turned down to 1/8 inch anyhow, so keep this in mind. Also check out the tutorial called "No Lathe Trike Hubs" on our website to see how these flanges can be made using nothing more than some 2.5 inch flatbar.

Update: We are manufacturing these hub flanges to help you complete your trike, so check the "Parts" section on AtomicZombie.com to check on availability.

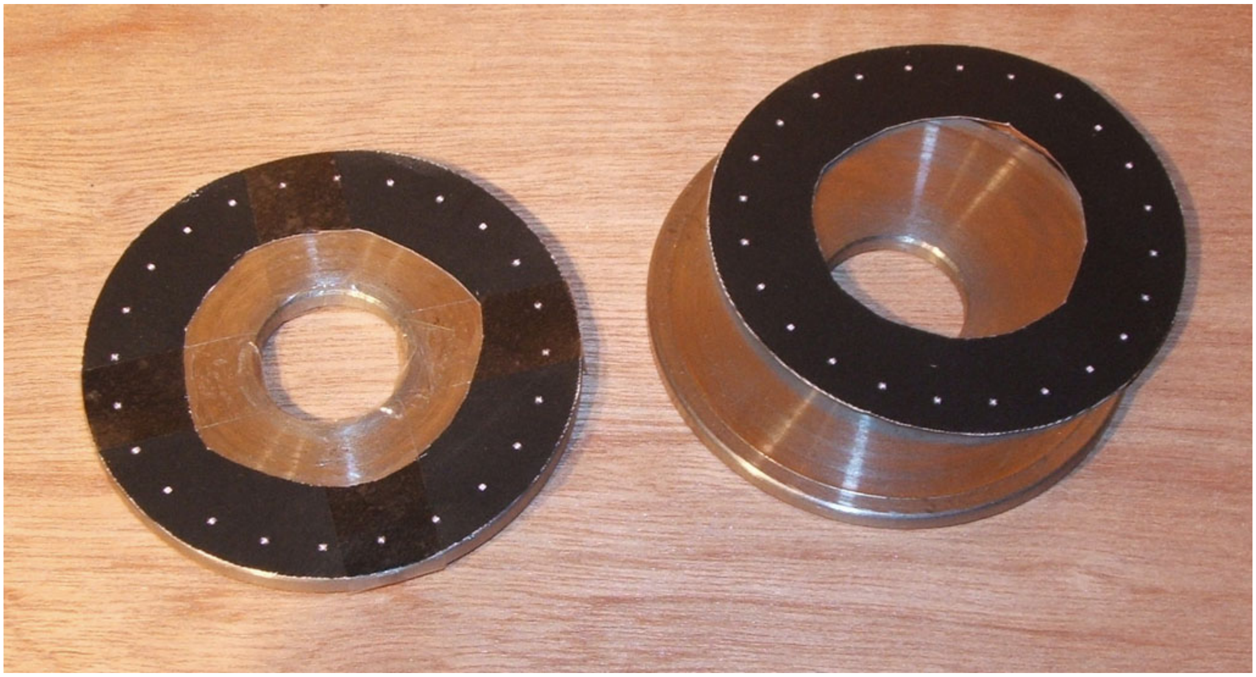


Figure 14 - Using a template to punch drill guide holes

The four hub flange discs are made of mild steel 1/8 inch thick and approximately 2.5 inches in diameter (the diameter of the original hub flanges). The hole in the center is 3/4 inch in diameter so that the discs will fit snugly onto the 3/4 inch axles used on the Aurora Trike. The 24 spoke holes in each disc are drawn using a compass or by punching through a paper template made in a computer program like AutoCAD or Photoshop as shown in Figure 14.

Just like the original hubs, there should be no less than 1/8 of an inch between the edge of the disc and the closest edge of the spoke hole to make the disc as strong as possible. The goal is to duplicate the original size and drillings of the original hub flanges that came with your wheel as much as possible, which is why I decided to print out the template so I could lay it directly over the original hub to make sure that it matched perfectly when held up to light. It took me a few tries to get the correct size to print out of Photoshop on my laser printer, but was well worth the effort.

Since the flanges are based on the size of the original bicycle hub flanges, you will have to make your own hole punching template. If computer graphics or CAD is not your thing, have a “nerd” friend help you make the templates. The templates are very easy to make using any CAD software.

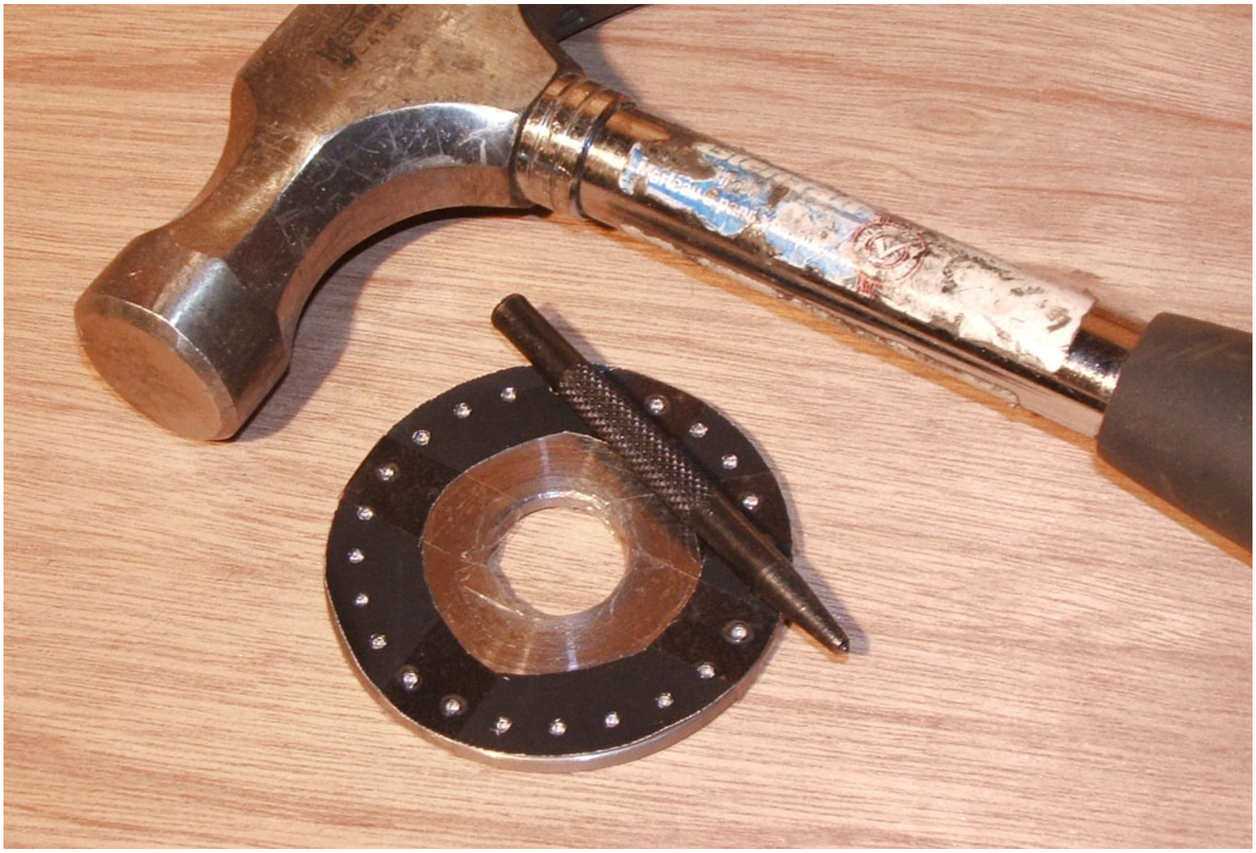


Figure 15 - Punching drill guide holes through a template

As shown in Figure 15, punching the guide holes used for drilling is easy by placing the tip of the punch over each hole and hitting it with the hammer. The key is to make sure that your template or compass marks are accurate to make your wheel lacing job easier, although a small error will not have much effect on the final wheel once trued. I know that my template is accurately taped into position because I cut the black circle out so that once cut was exactly the same diameter as the flange.

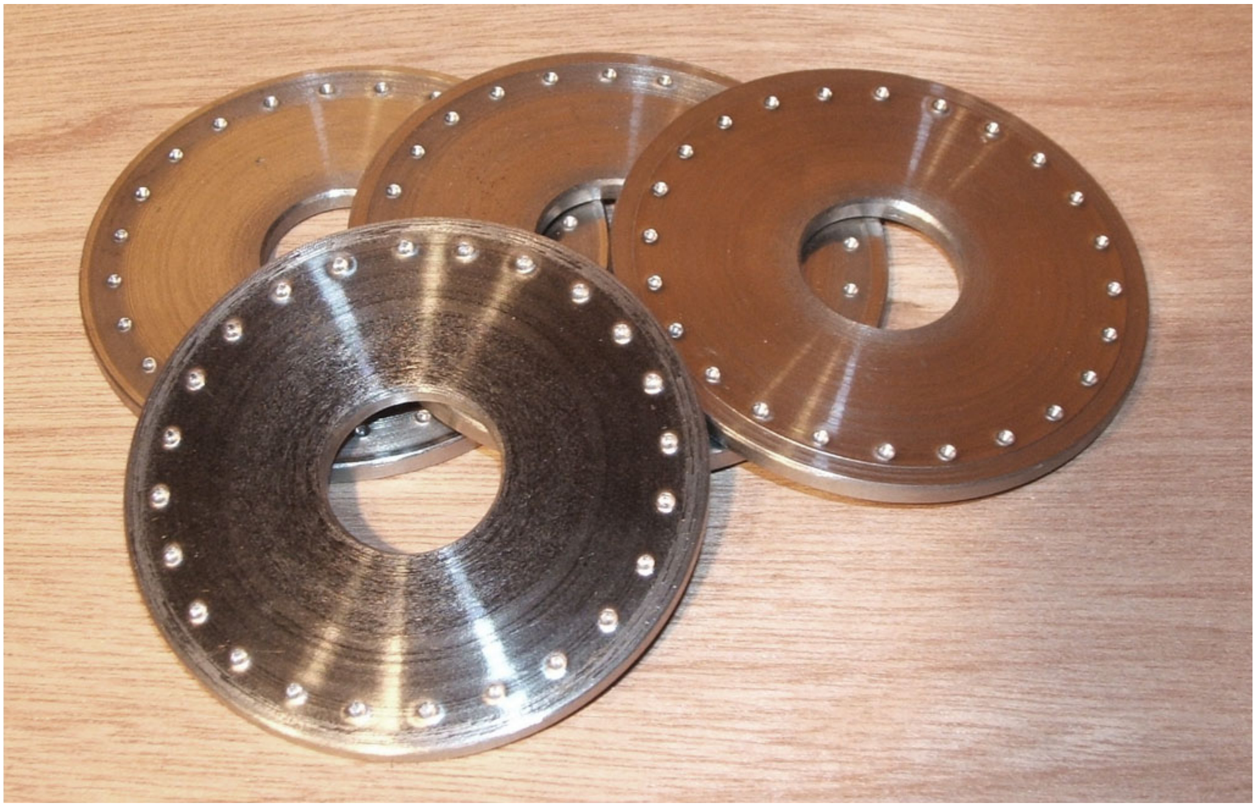


Figure 16 - Ready for drilling

After punching the 96 drilling guide holes as shown in Figure 16, your four hub flanges are ready to be drilled. The process of drilling 96 holes is not hard work, but it is mundane and repetitive so crank up your favorite music and try not to fall asleep with a running drill in your hands!

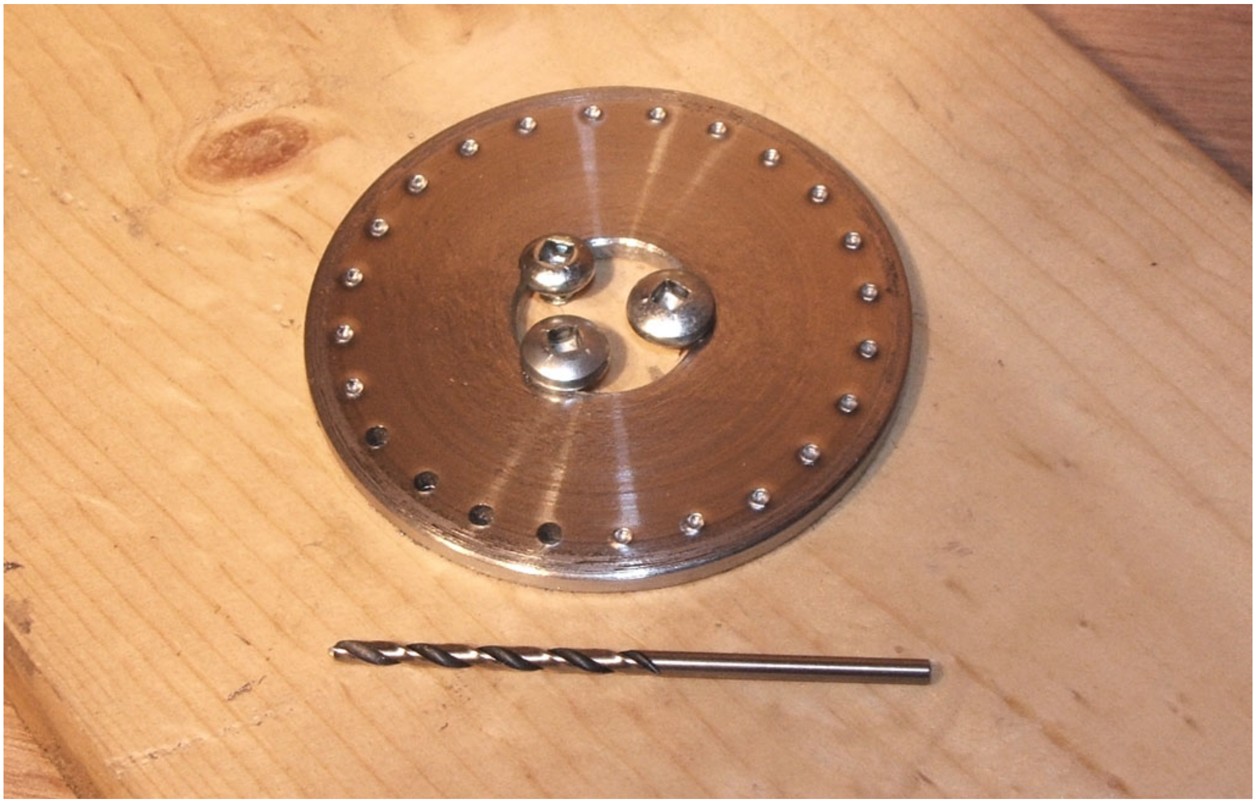


Figure 17 - Drilling the spoke holes

Builders Tip

The spoke holes will be drilled using a 7/64 inch drill bit. It may seem like a lot of work to drill 96 small holes, but in reality, this entire job only takes about an hour depending on the quality of your drill and bits. I am a minimalist and do not own a drill press, so I do this work using a hand drill, which is why the disk is held to a board as shown in Figure 17 by a pair of wood screws.

Drill & turn, drill & turn, drill & turn - I am truly thankful that I do not manufacture bicycles for a living or this hobby would quickly turn into a real chore! My hand drill was getting a little warm by the time I reached hole number 96, but I made it non-stop in less than an hour. If one of the spoke holes is slightly off center, do not fret; you will be able to adjust this during the wheel truing process, and it will not affect the wheel in any way. I would recommend that you use a new bit for each disc, as they eventually do wear out and the small bits are cheap enough to replace when worn.

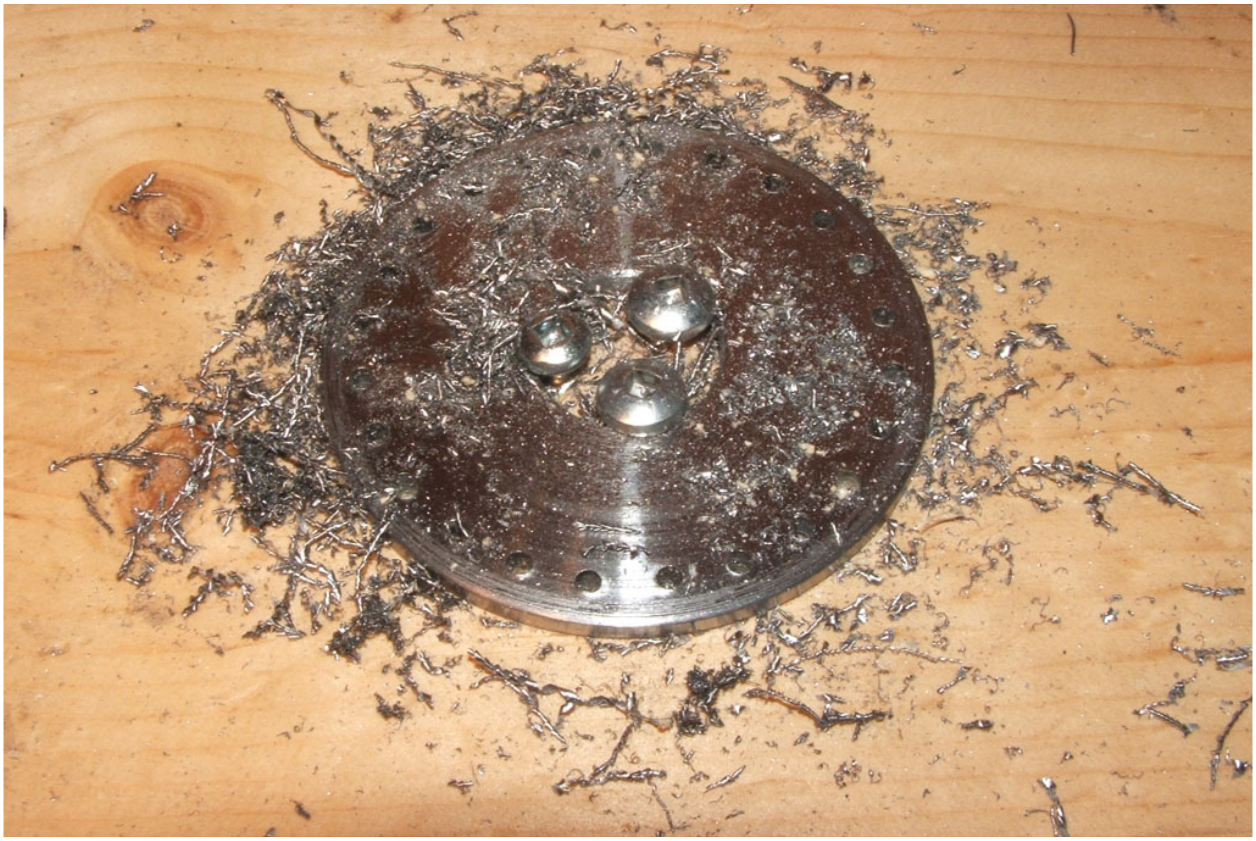


Figure 18 - Drilling the hub flanges

A little cutting oil will help to keep the bits sharp, but if you find yourself pressing hard on the drill, switch to a new drill bit. Figure 18 shows the result of 15 minutes of monotonous drilling on the first flange. This is really a job for a machine, but these four discs didn't take me very long to make.

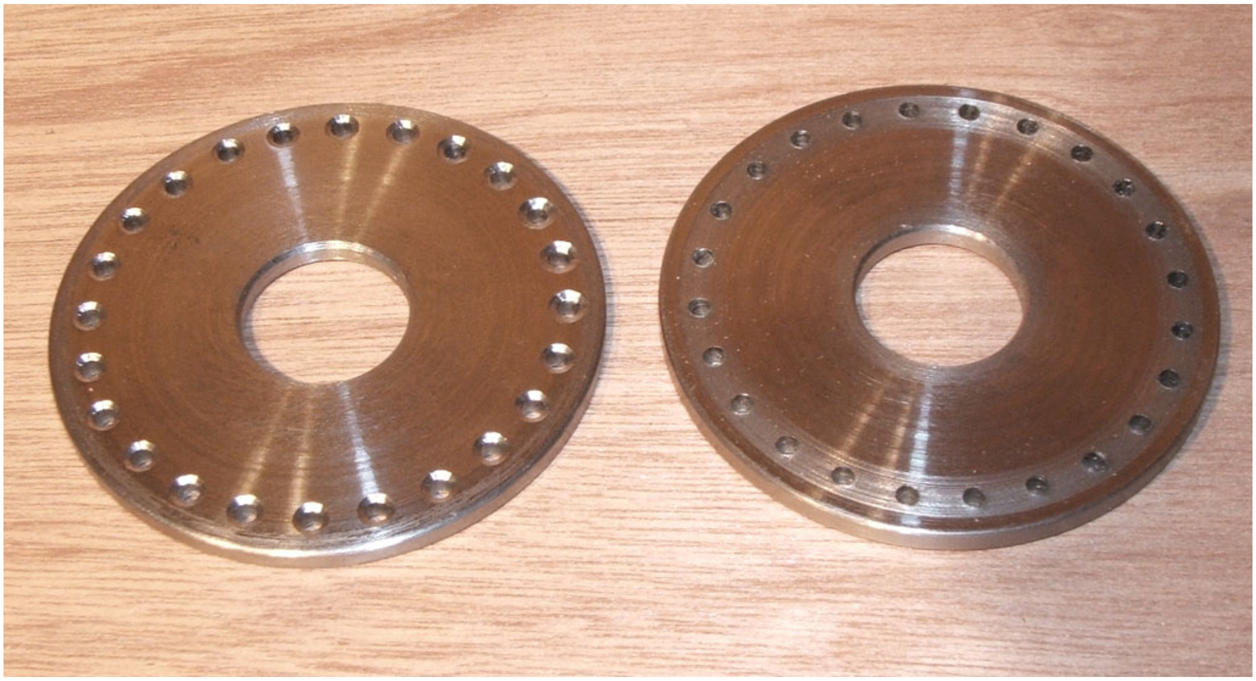


Figure 19 - Beveling the spoke holes

If you look closely at a standard bicycle hub, you will notice that the holes are very slightly beveled on each side so that the spoke bend is not subjected to a very sharp edge as it exits the spoke hole. This process can be re-created by simply running a 1/8 inch drill bit lightly into each hole for about two seconds. The result will be beveled holes like the ones shown in Figure 19 on the left disc.

Do not put any pressure on your drill when doing this operation, or you may drill into the hole, which is why a hand drill may be the best tool to use when doing this operation. The goal is to smooth off the sharp edge without making the entire hole any wider. Do this to both sides of all of the holes in each flange. To avoid pressing too hard, I held the flange in one hand and the drill in the other, pressing the flange lightly against the spinning bit to bevel the holes.

✓ Builders Tip

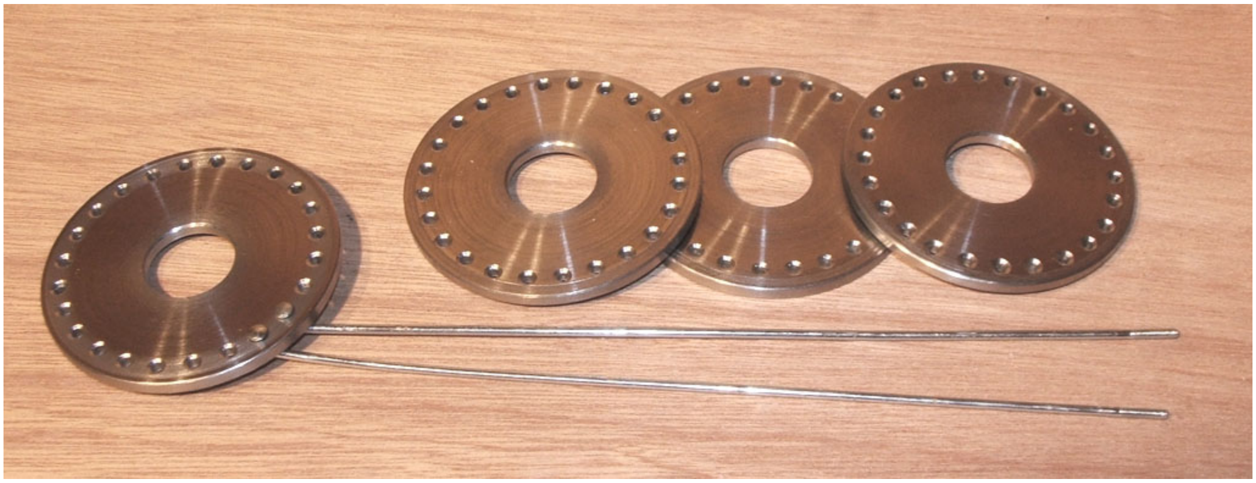


Figure 20 - Completed and beveled hub flanges

With a little patience, you will have four perfectly drilled and beveled hub flanges as shown in Figure 20. The spoke fits nicely into the hole and makes the bend without any force just like it did in the original aluminum wheel hub. If your hub flanges were made from material thicker than 1/8 inch, you may have great difficulty getting your spoke to make the bend, which is why a flange thickness of 1/8 was specified earlier. Do not attempt to make any new bend in a spoke, or its strength will be seriously compromised and the length will be reduced. If using material thicker than 1/8 your only option is to have the piece turned down to 1/8 inch on a lathe or try to make the bevel on each hole a little wider.

As you will see by reading ahead, the hub flanges are to be welded to a pair of axles that will fit into the pillow block bearings after they are bolted to the frame. When you are sourcing the axles, tell the supplier that you are planning to weld something directly to them and that they should be made of non-hardened steel. What you want is cold rolled 3/4 inch steel shafting. If the steel is hardened, it could become brittle after welding, leading to a failure. You should also purchase double the length of axle rod you will need (about 6 feet in total) so you can use the other half as an alignment guide when setting up the pillow blocks on the rear frame. This alignment system will be shown in the next few steps.

From your six feet of axle rod, cut three lengths: 1 foot, 2 feet, and 3 feet. The 1 foot long axle will be on the right side of the frame, the 2 foot long axle will be on the left side (drive side) of the frame, and the 3 foot long axle will be used as a guide to align all four bearings. These lengths are made to be longer than necessary, and if you made your frame wider than 23 inches, you may need to also increase the axle lengths. Read ahead to see how the axles will be connected to the frame.

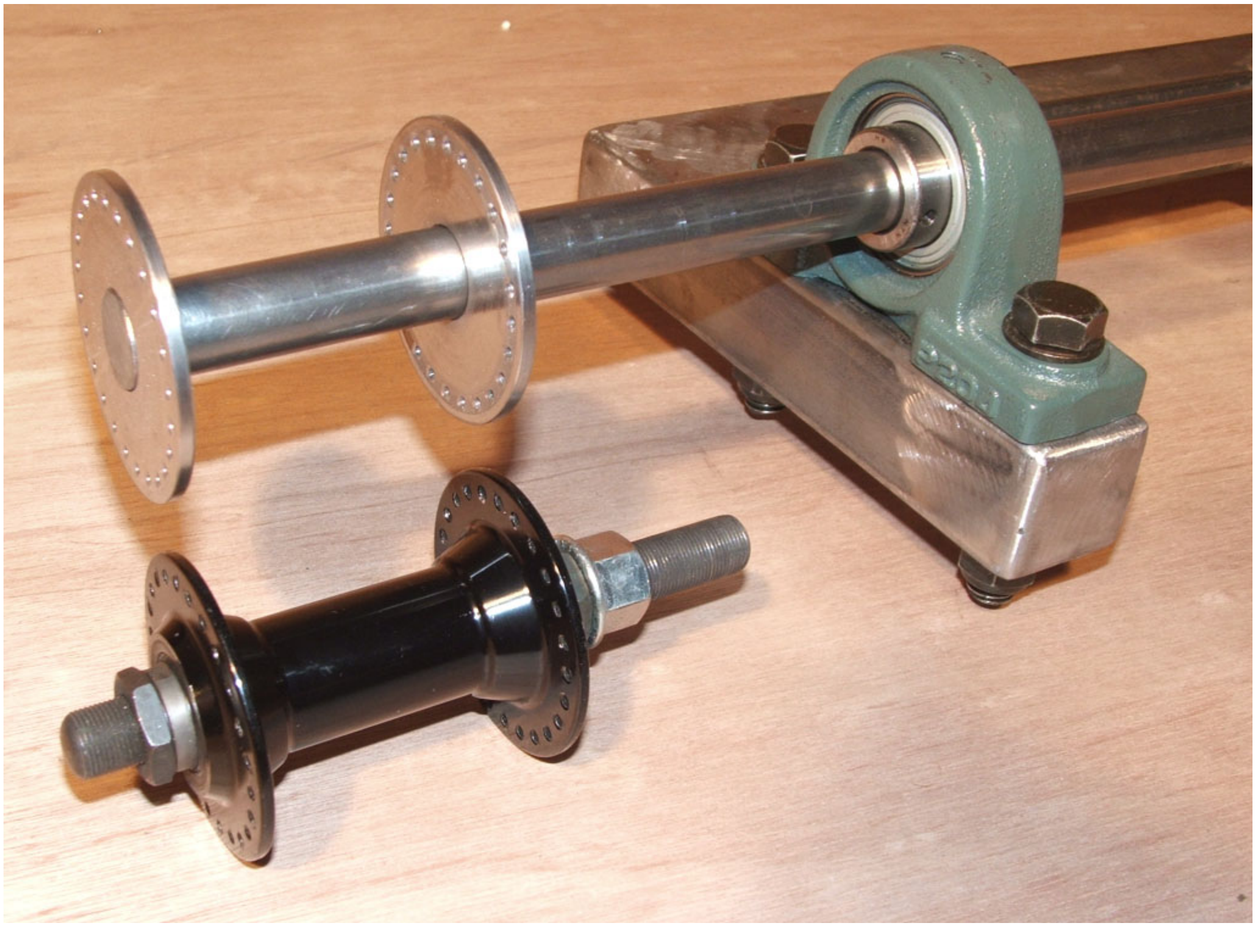


Figure 21 - Matching hub flange distance

In order to lace the rims into the new hub flanges, they need to be welded directly to the ¾ inch axles so that they are spaced apart the same distance as the hub flanges from the original bicycle hubs (typically 2.75 inches). By doing so, you will ensure that all of the original spokes are the correct length. Figure 21 shows how my hub flanges will be welded to the axles by using the original hub as a guide to get the correct flange spacing. Measure the distance between the centers of the original hub flanges, the mark the axle using this measurement. If you don't have any hubs to use as a comparison, just place the flanges on the axle with a 2.75 inch spacing.

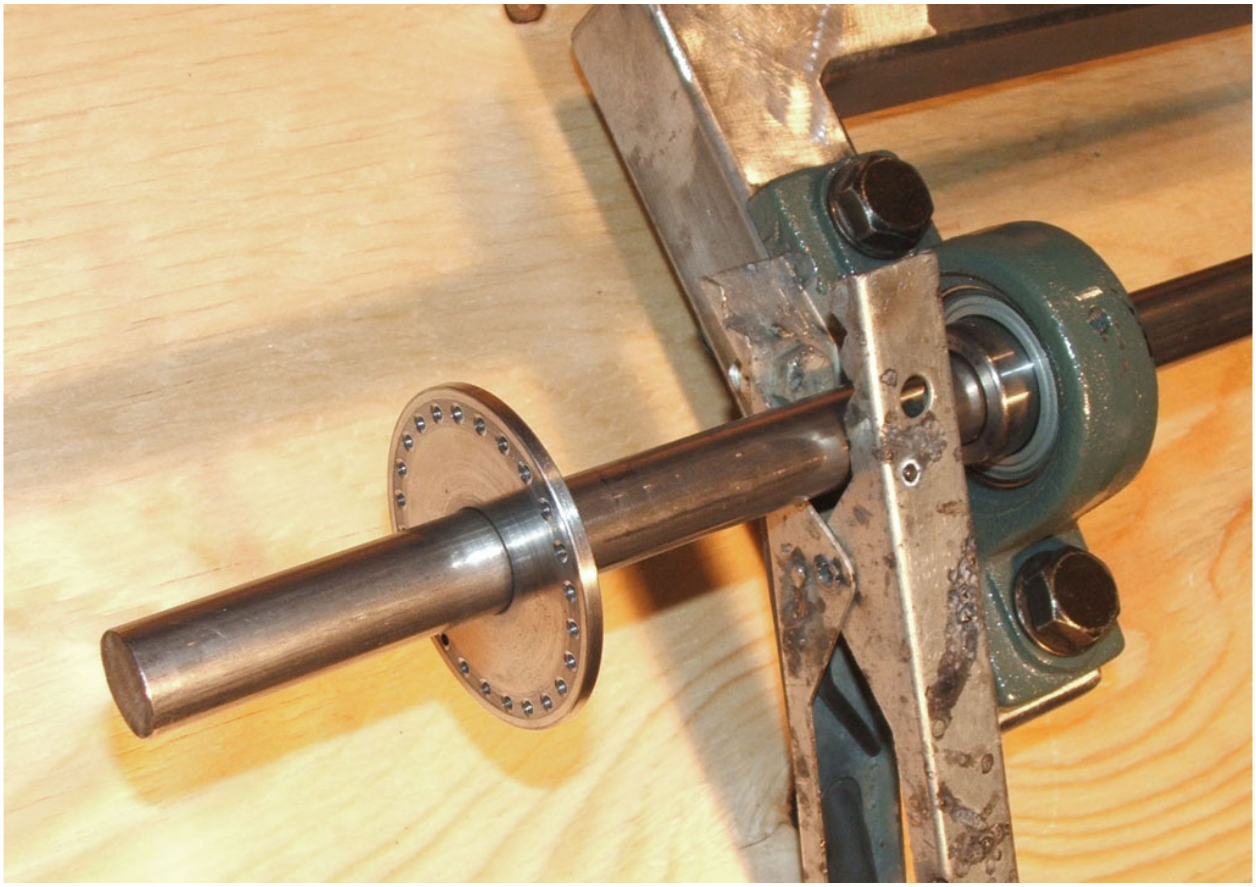


Figure 22 - Welding the flanges to the axle

The inside flange will be the first one to be welded to the axle, and as shown in Figure 22. If you are using a bearing to hold your axle while welding, the ground clamp should be placed directly on the axle, not the frame or bearing. You should never place your welding ground clamp in any place that would cause the current to flow through the bearings into the weld area. If you clamped to the frame, the current would need to travel through the inner and outer bearing races and through the actual ball bearings in order to complete the circuit, which will damage the bearings.

✓ Builders Tip

Since each ball bearing only contacts the inner and outer races by a very small surface area, the high welding current will create a pit in the bearing races, causing what would seem like years of wear on the bearing. Place the ground clamp on the axle, not the frame or bearing, and you will avoid this problem when using the bearings to hold the axle while welding.

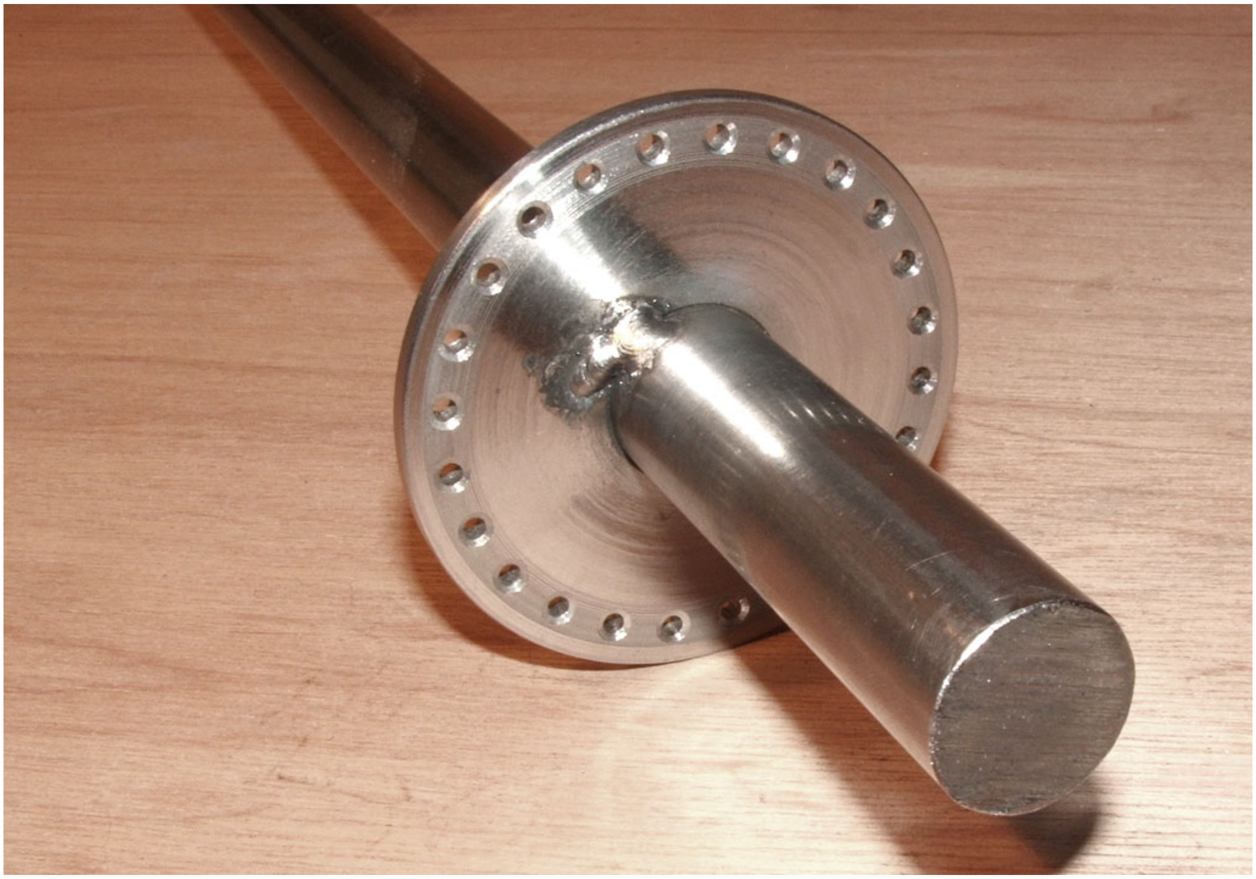


Figure 23 - Tack welding the inner hub flange

The hub flanges should slide snugly onto the axle, but there will still be a little bit of play, so make a small tack weld on the flange as shown in Figure 23. Notice that the welding will be done on what will become the inside of the flange, not on the side that mates with the bearing collar. Once the tack weld has cooled, remove the ground clamp and spin the axle to check alignment. It is very easy to see any misalignment of the flange as you turn the axle, and this is corrected using a few small taps of a hammer along the disc until it spins true.

A very slight wobble is not a big deal in the end since the spokes will correct this, but do try to get the disc spinning as true as you can while it is easy to manipulate. If you are using washers as the hub flanges, the hole in the washer may be a lot larger than the axle, so you will have to shim it while making the first few tack welds. Even a gap of 1/8 inch all around the washer hole should not be a problem, as the weld bead will fill it in.

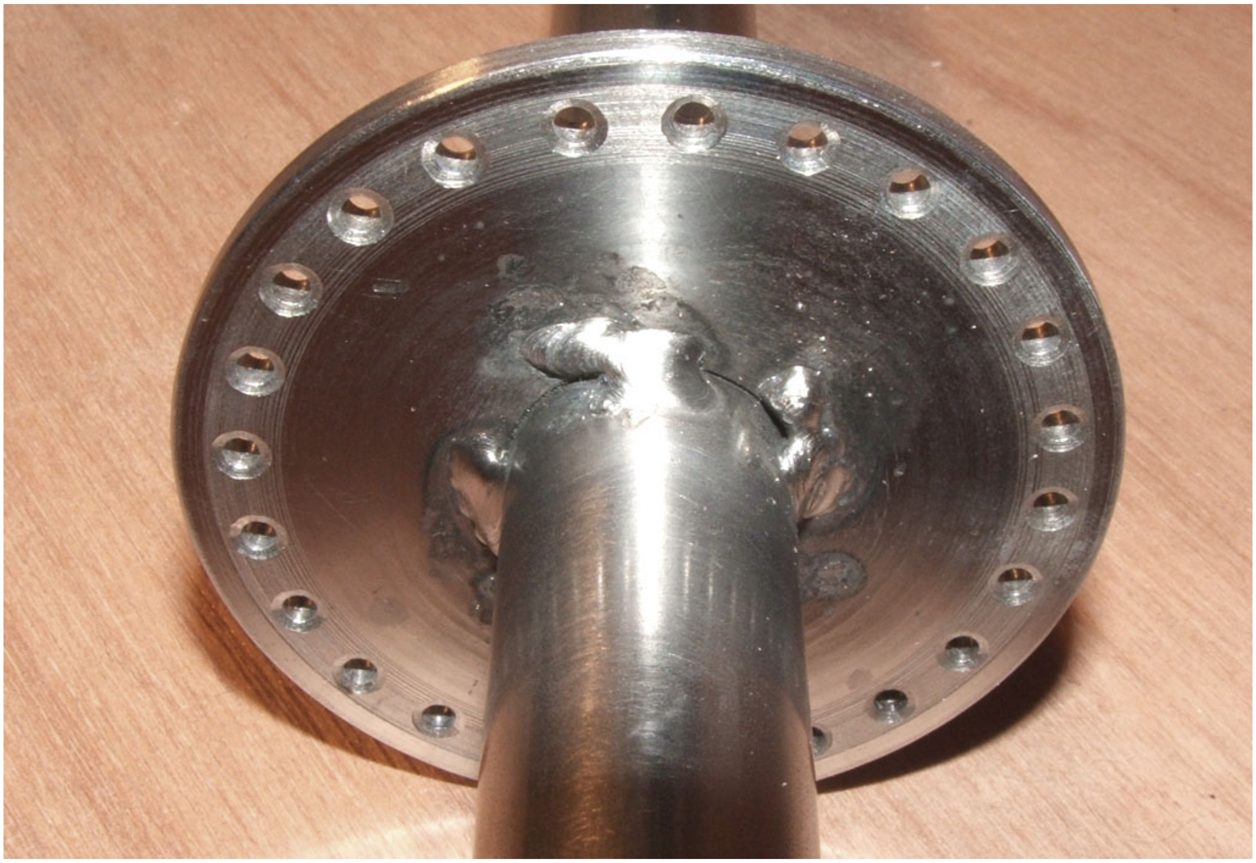


Figure 24 - Four tack welds hold the flange

Once you have tapped the flange into alignment from the previous step, add another tack weld directly opposite of the first tack weld then repeat the spinning and tapping process to true the disc back up. Repeat this process until your hub flange looks like the one shown in Figure 24, with four decent tack welds holding the flange to the axle in as perfect alignment as you can get it. Remember to keep that ground clamp off the frame or your bearings will be destroyed. If you had to shim up the axle gap due to an oversized hole, you can now remove the shims as the four tack welds will be more than enough to hold the flange in place for welding.

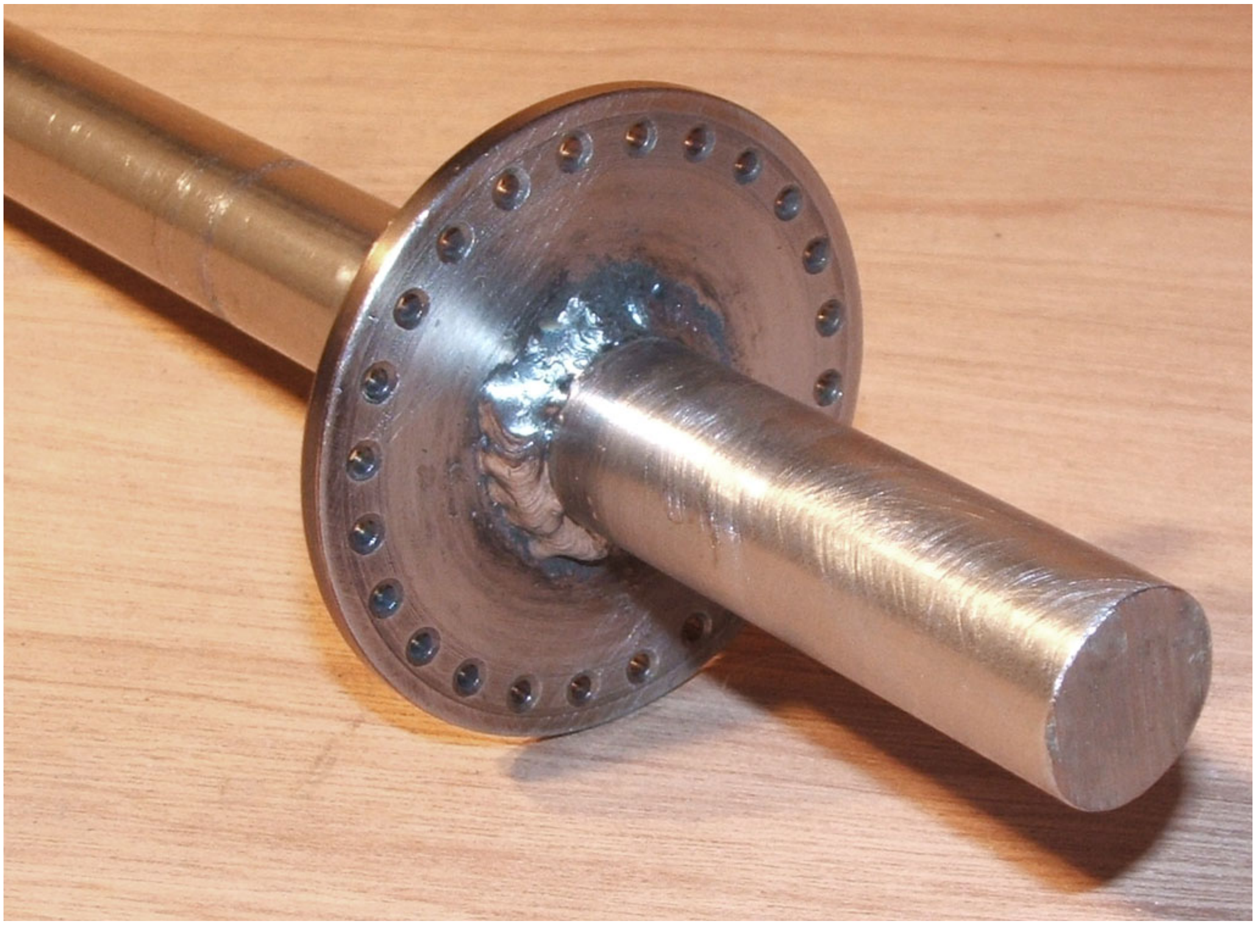


Figure 25 - Inside hub flange welding complete

The hub flange can now be welded around the entire joint as shown in Figure 25. If you get a helper to slowly turn the axle while you weld, it is possible to do the entire joint in a single pass. Once you are done welding the entire joint, place the axle back into the pillow block bearings and give it a spin to check alignment. You may want to place a bit of masking tape around the spoke holes while you are completing the welds; this way, spatter won't get stuck in the holes. If you do get some spatter in the spoke holes, a small finishing nail can be used to clean them out.

A very slight wobble in the flange is not a big deal, but if you think there is too much misalignment, a few whacks of the hammer may still cure this. Any misalignment less than the thickness of the actual disc will be acceptable and will have no effect on the wheel lacing process, nor will it show in the final build, so do not spend too much time and effort trying to get the disc spinning with "military accuracy". Do not weld the other side of the joint on this flange, it is not necessary, and will only make it more difficult to center the axle and disc brake later.

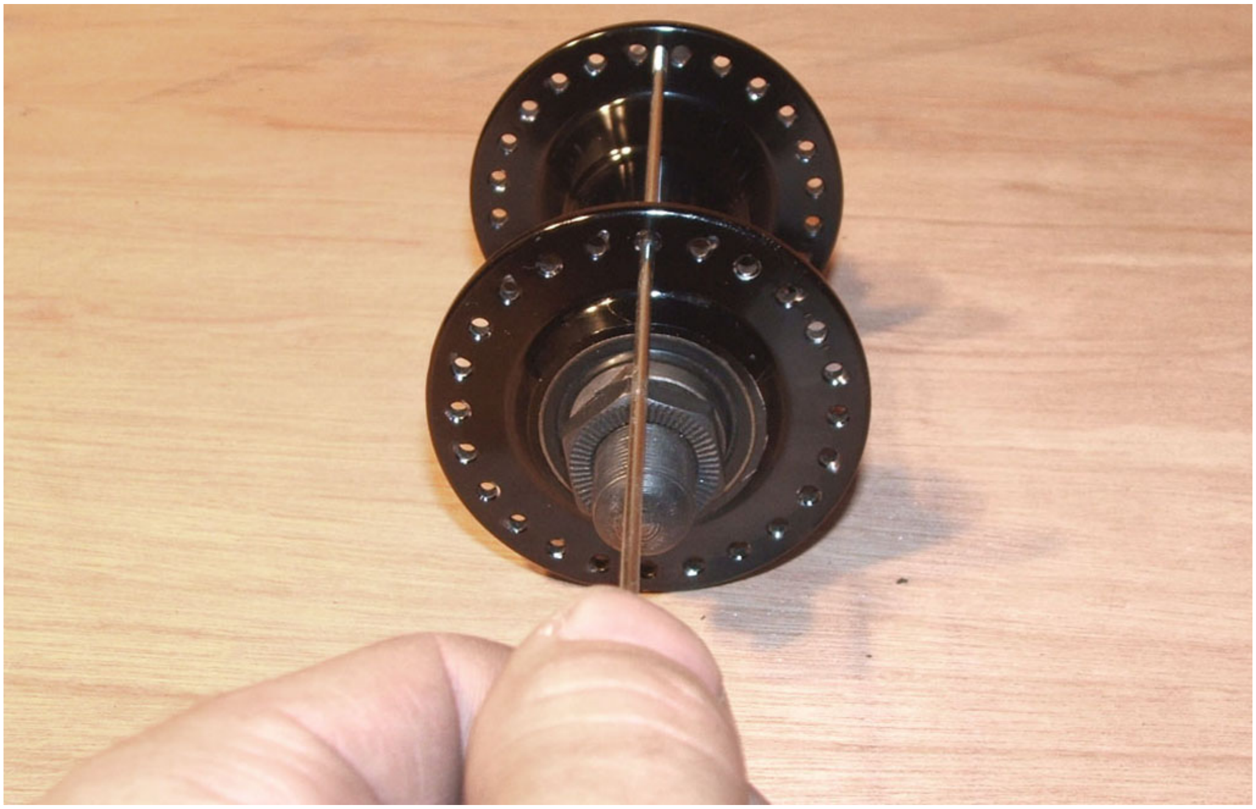


Figure 26 - Spoke holes are offset on each flange

Before you start welding the outer flange, have a look at the original hub and you will notice that the holes on each opposing flange are offset to each other. If you place a rod or spoke through one of the holes, it will not enter a hole on the opposing flange; it will hit the space between the holes. Every bicycle hub is manufactured like this, even the cheap steel units, and this offset is an important factor to increase wheel strength once the spokes are in place. Set up the flanges on each axle with this spoke hole offset as you add the opposing flange. A spoke or small welding rod can be used to check this as shown in Figures 41 and 42.

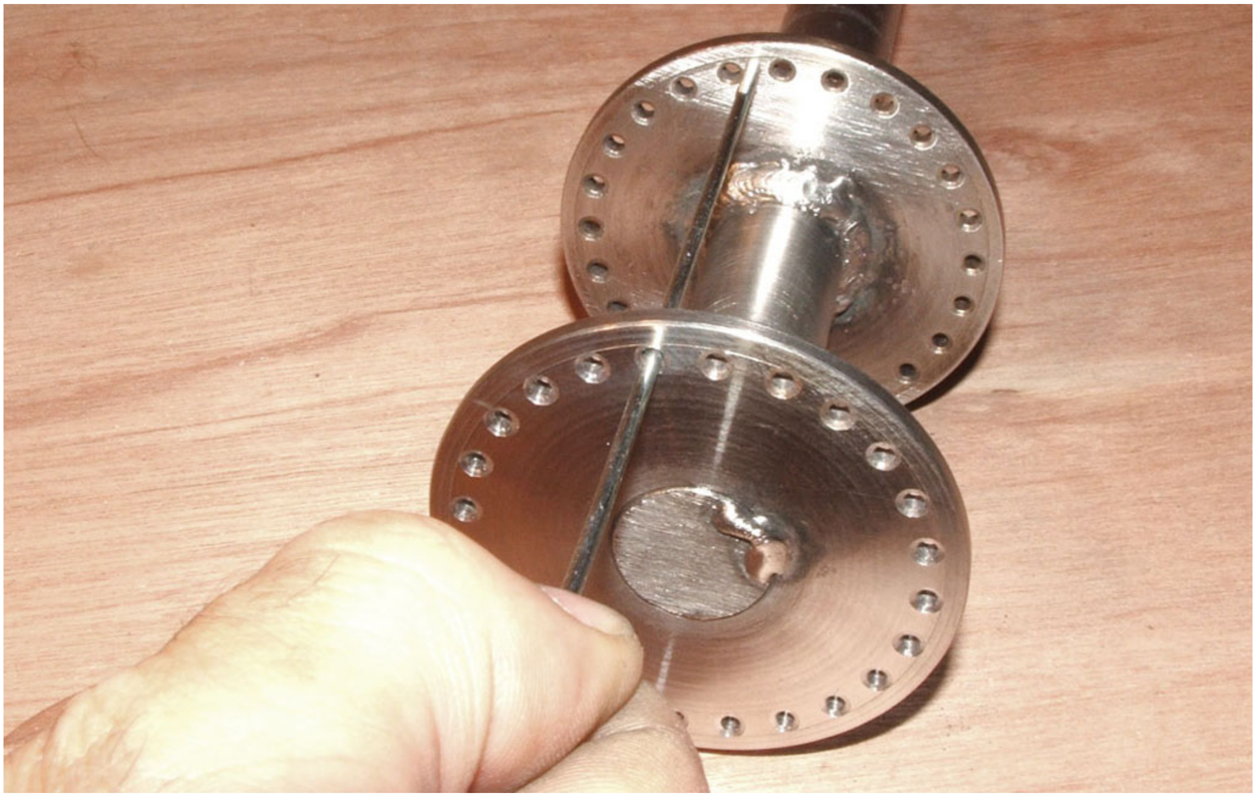


Figure 27 - Checking hole offset after tack welding

As shown in Figure 27, the same process that is used to mount the inner flange to the axle is also used to mount the outer flange as well, but do not forget two important points - always place the ground clamp on the axle, not the frame, and make sure that each flange has the opposing spoke holes offset to one another. Other than that, tack, hammer, tack, hammer until you have completed all of the welding. The outer flange will be welded on both sides of the joint, but complete the welding on the outside of the joint (hub face) first before welding the other side.

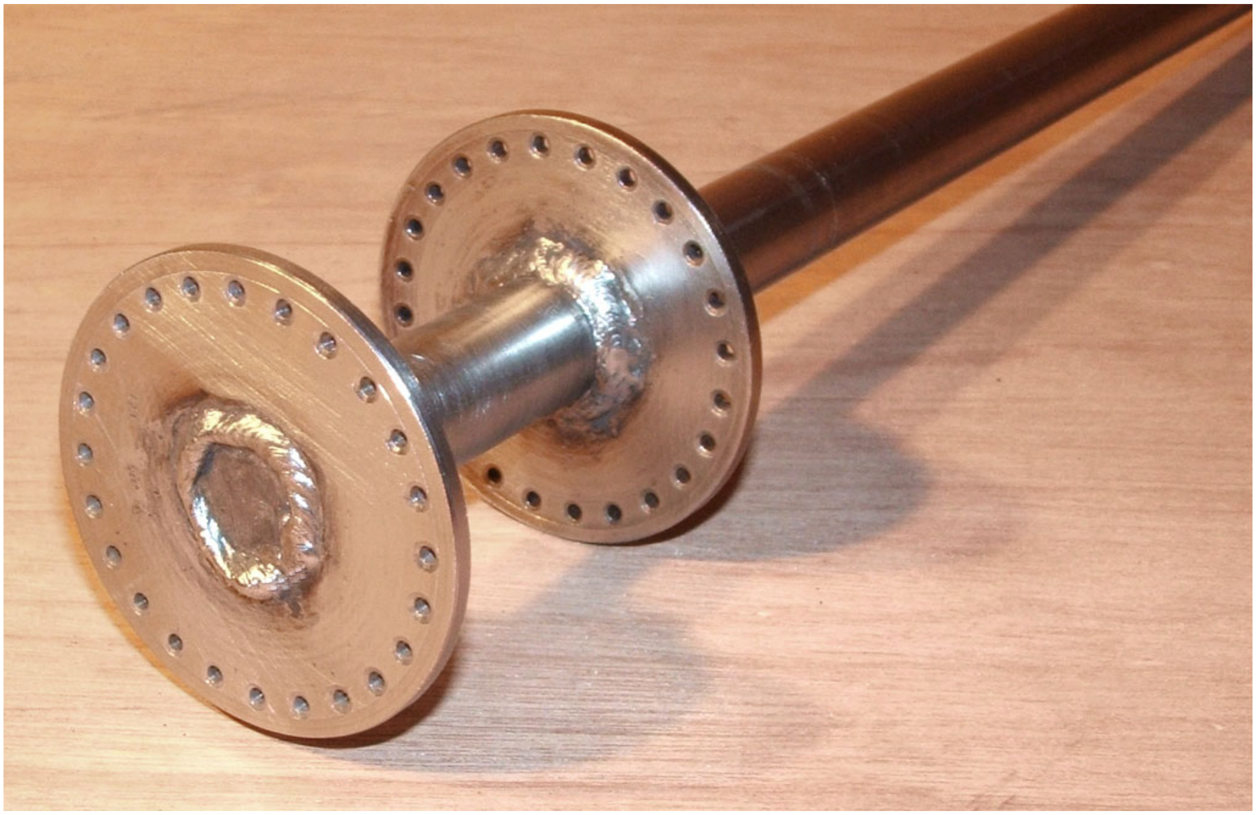


Figure 28 - Outer flange welding completed

Once you have welded the entire outside flange joint, you can then weld the other side of the outer flange without any worry of distortion due to welding heat. Don't forget that hole offset - it is very important. Figure 28 shows one of the completely welded axle/hub units ready to have the face ground flush.

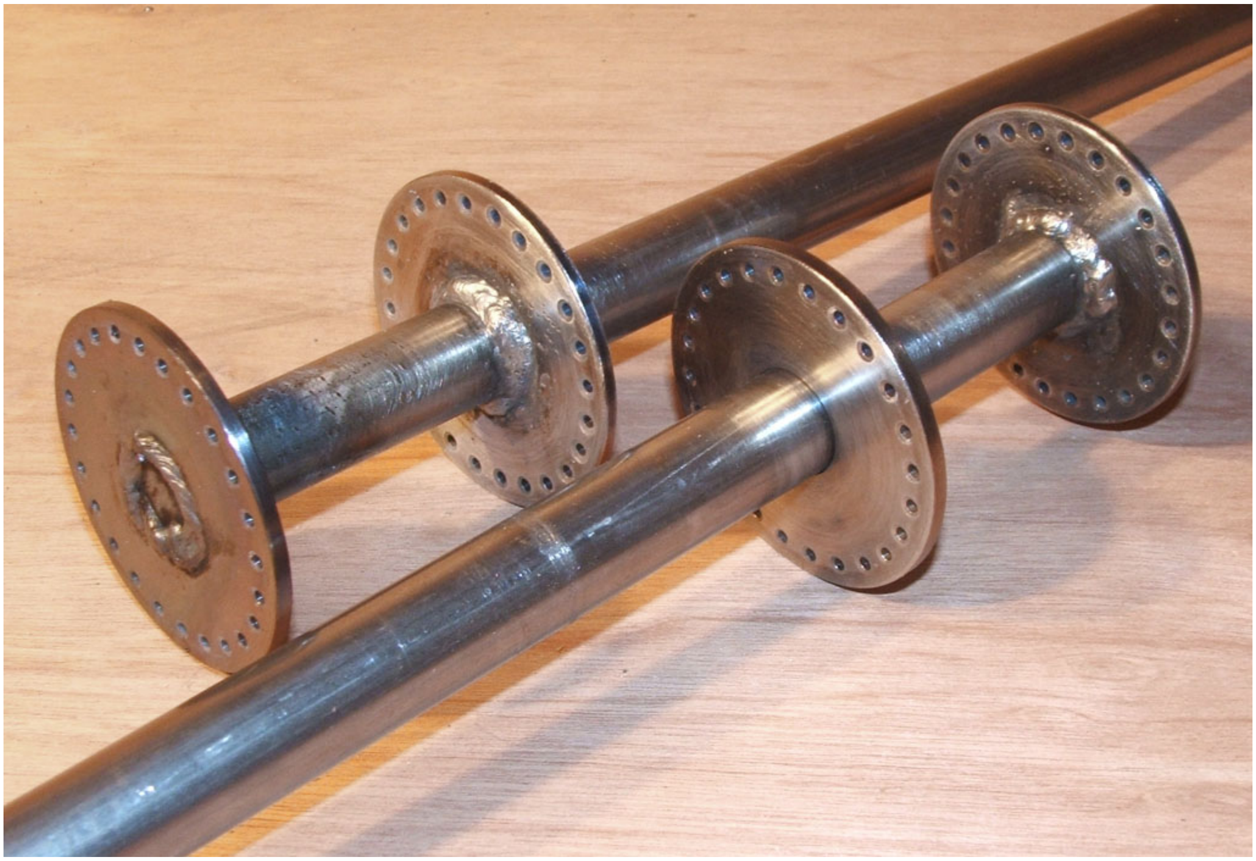


Figure 29 - Both hub axle units completed

Once you have both axle/hub units completed as shown in Figure 29, take your grinder and remove all weld material on the face of each hub using a sanding disc until the face perfectly flush. Don't worry about the fact that most of the weld metal will be taken away; the inner flange welds and weld on the other side of this flange will hold the wheel on to the axle. I like to start grinding with a heavy disc, and then once I'm almost to the face, I then place the axle back into the bearings and work it flush with a sanding disc. You can have a helper turn the axle while you grind, or simply let it spin while you work to create a face that looks as though it were turned down in a lathe. Yes, you could also turn the face down in a lathe of you are lucky enough to have such tools.

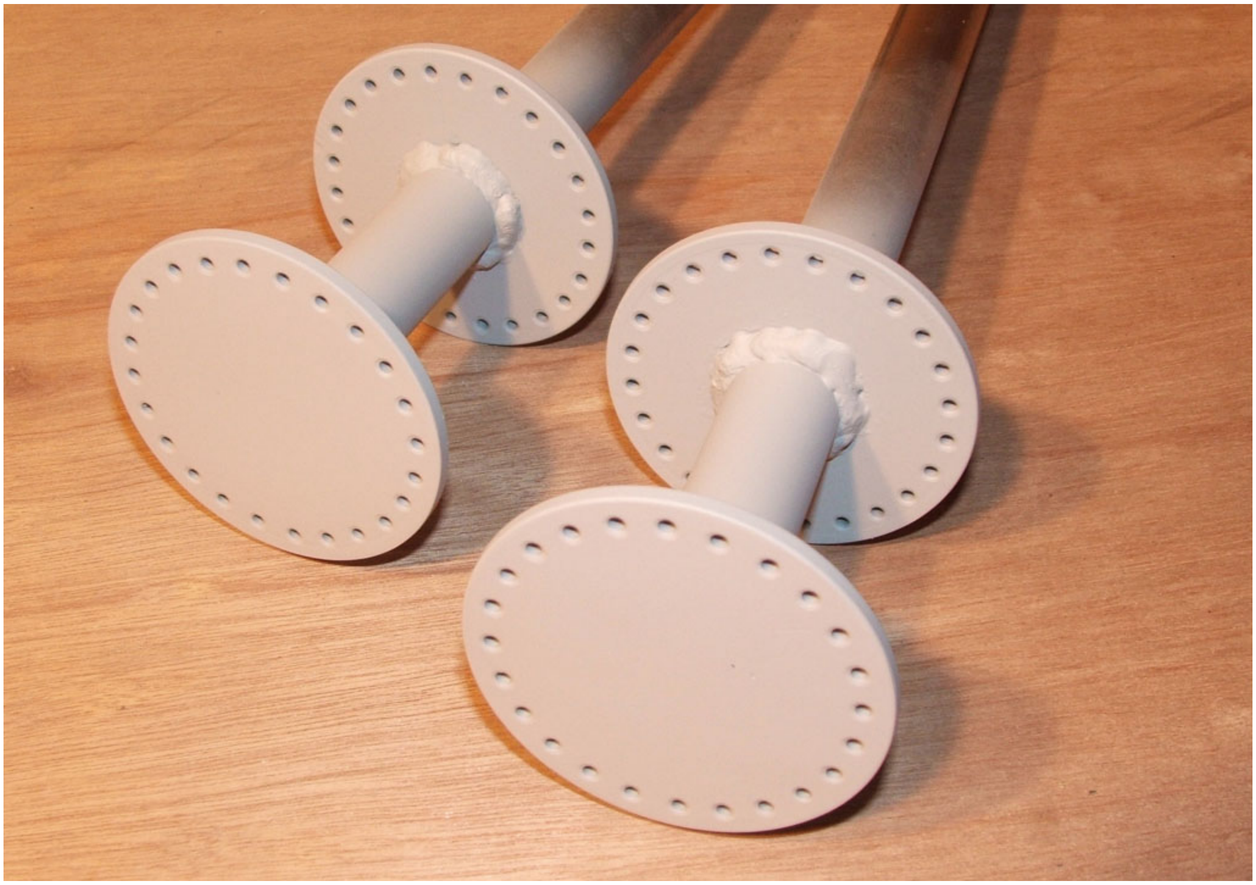


Figure 30 - Hub axle units primed and curing

Since you will not be able to paint the hub axles units after the spokes are installed, they must be done first. Figure 30 shows the completed hub axle units with a fresh coat of primer. Notice how the flange faces show no signs of being welded to the axles, as if the entire unit was turned down in a lathe from a single piece. It is a good idea to tape off the axle around the flange so you do not get paint in it, as it will need to be removed in order to fit the axle into the bearing. Yes. I forgot to do this!

✓ Builders Tip

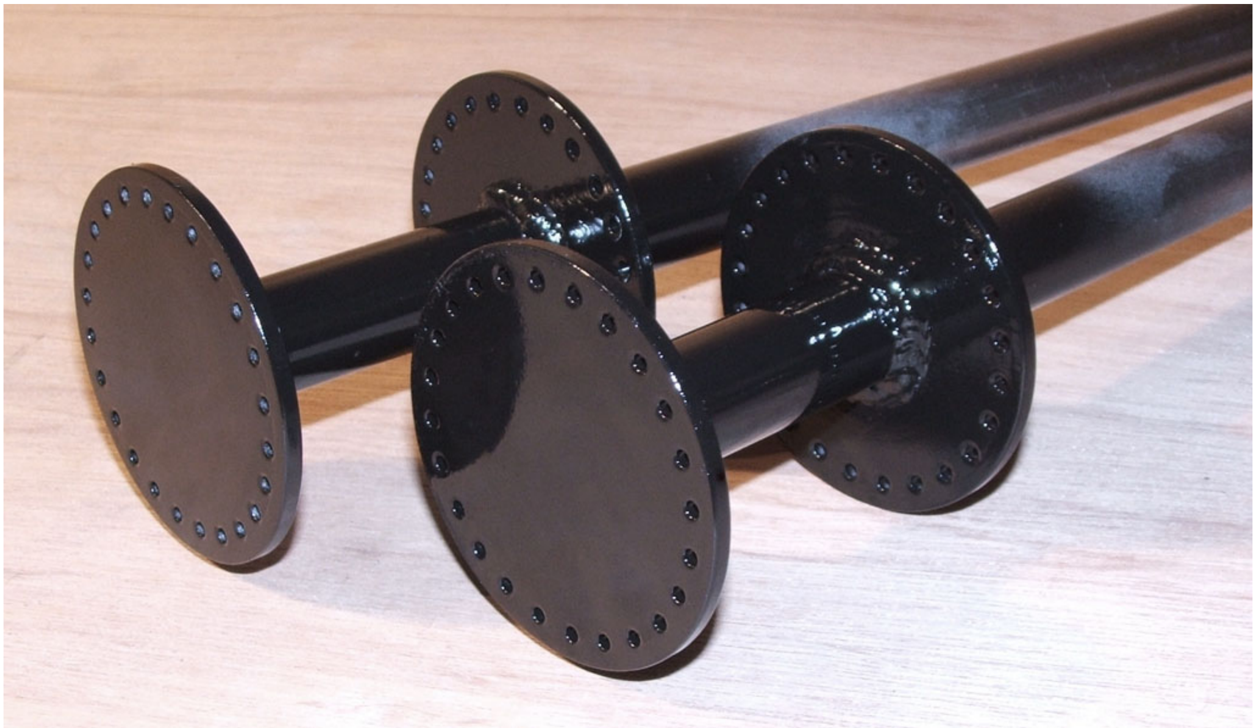


Figure 31 - The painted hub axle units

After a day of curing, the primed hub axle units were then painted as shown in Figure 31. Allow the paint to cure for at least a day before lacing up the wheels or you may scratch the paint. The rear wheels need to be laced onto the hub axles before any more of the frame can be completed, so find a comfortable place to sit and get ready to spend some quality time with your spokes and hubs. Congratulations! You now have a set of ultra-strong DIY delta trike hubs and axles that look as good as any expensive manufactured units.

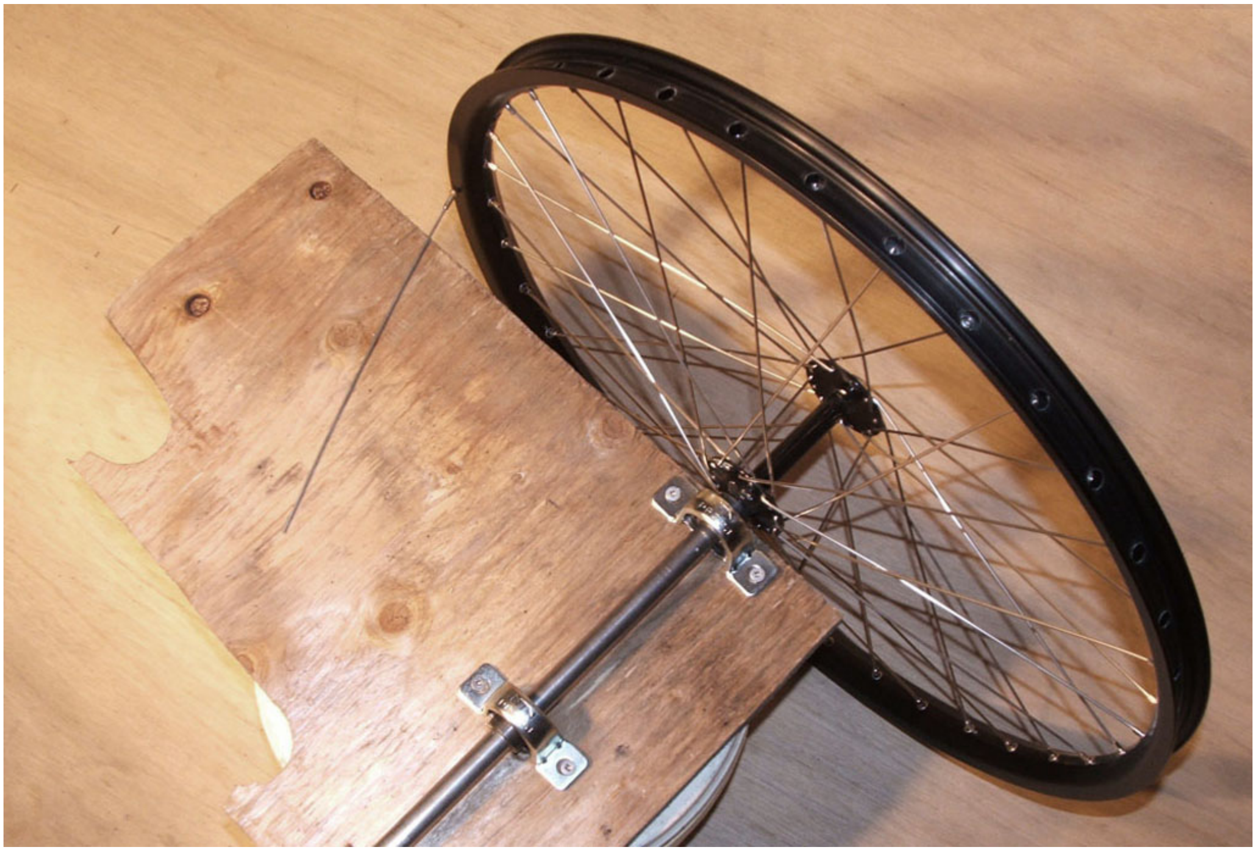


Figure 32 - Lacing and truing a wheel

Figure 47 shows my “poor man’s” truing stand, made by bolting down a pair of pillow block bearings on a piece of plywood so the wheel can be spun and referenced against the wood or a spoke placed against the rim edge. Installing the spokes is an extremely easy task that requires nothing more than placing the spoke in the correct hole and giving the spoke nipple a few turns with a screwdriver. It is the actual wheel truing operation that requires some skill or a bit of patience from those green to the art.

There are many great wheel building tutorials on the Internet, and you still have the complete front wheel to use as a guide, so with a little reading and patience, you can do this job yourself. Forty-eight spoke 20 inch wheels are probably the easiest of all wheels to build, and will true up quite easily. A bicycle shop can also lace up the wheels for you, but I guarantee you that anyone can do this job, and the satisfaction of doing it yourself is well worth the effort.

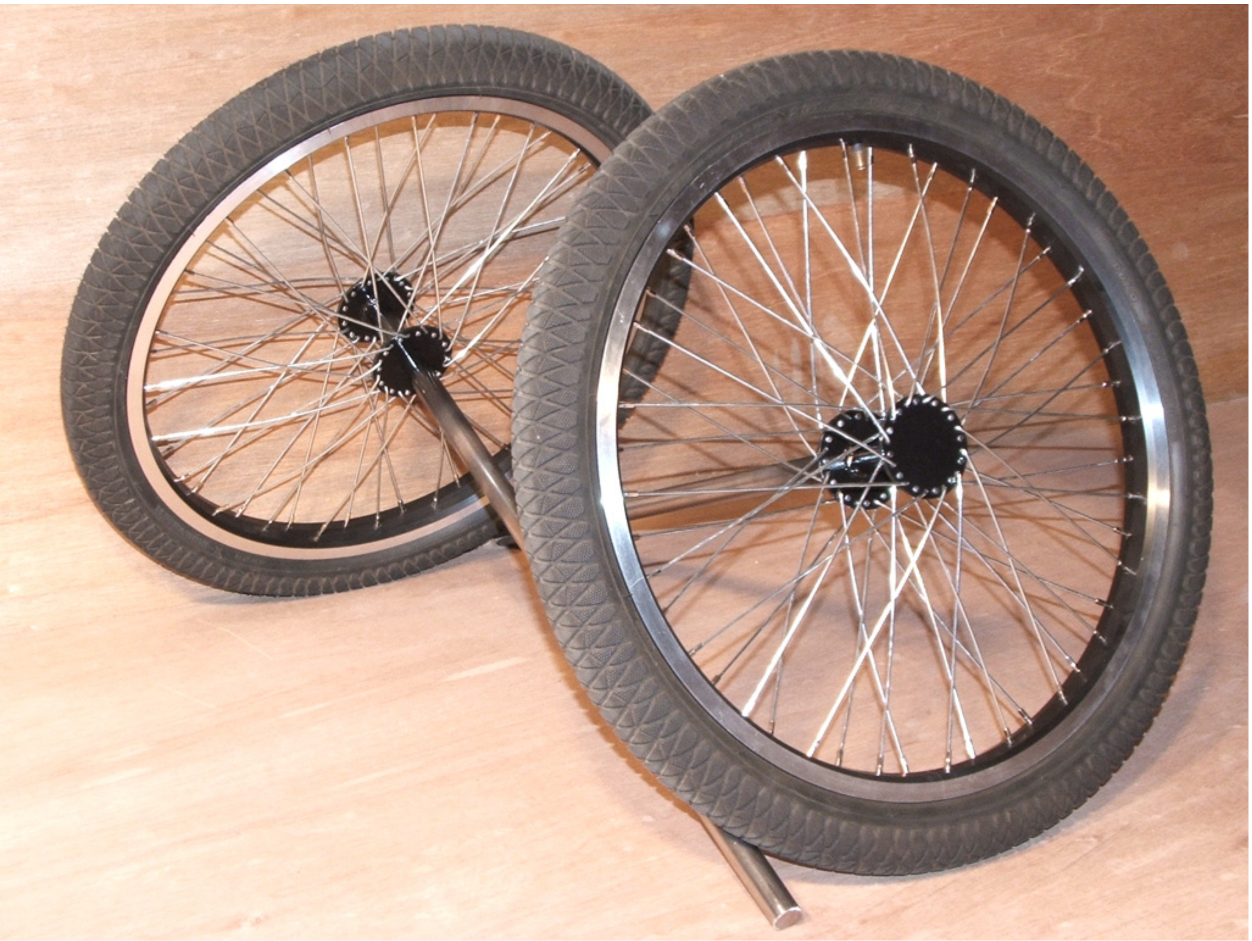


Figure 33 - Completed rear wheels

The completed rear wheels shown in Figure 33 took about an hour a piece to lace and true. Twenty inch wheels are much easier to true than larger rimes due to their extreme stiffness. If you tighten each spoke the same amount, chances are good that the wheel will be almost perfect on the first try. Try to get all the spokes under the same tension, not over tight or too loose. Use your front wheel as a guide, comparing spoke tension.

REAR AXLE BEARINGS

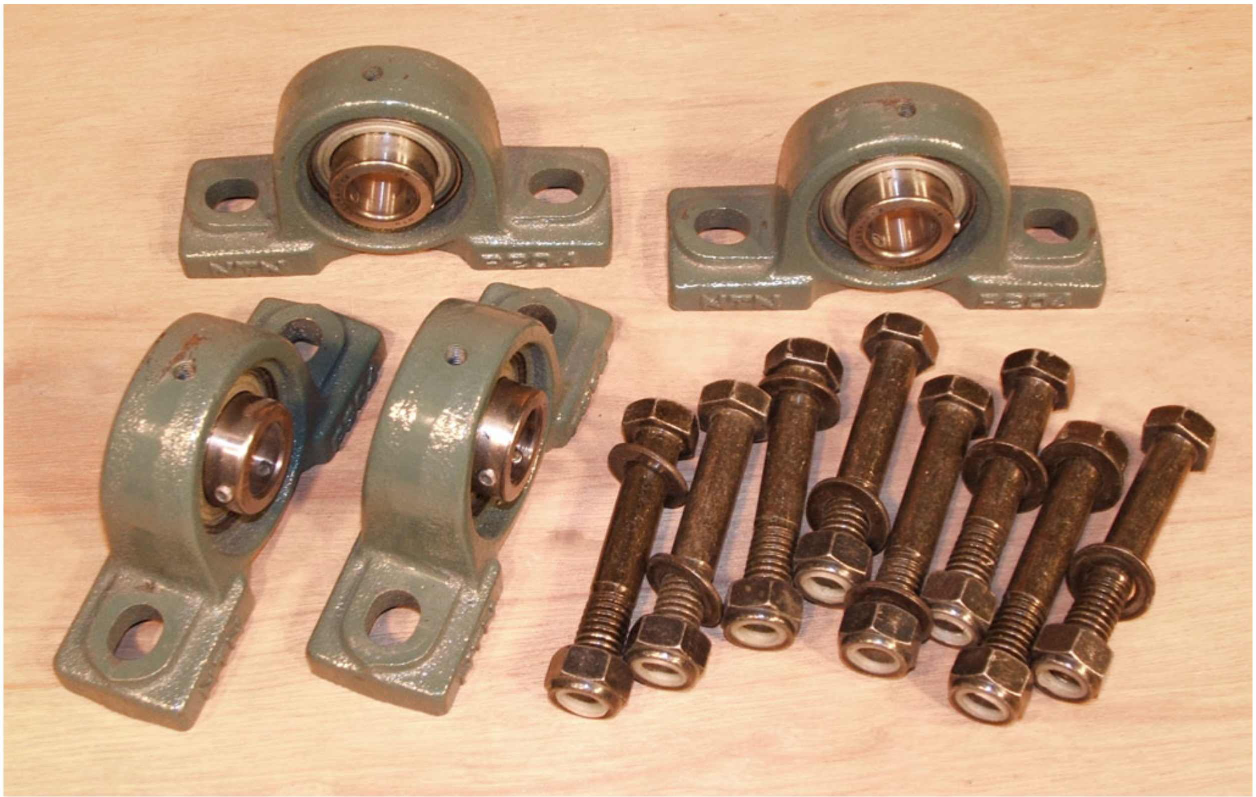


Figure 34 - Four pillow block bearings to fit the rear axle

The rear axles will be held to the frame using four pillow block bearings like the ones shown in Figure 34. The pillow block bearings that I used are standard cast iron units, and although they are a bit heavy they will last a lifetime without any maintenance whatsoever, even under rough environmental conditions. If you are good at sourcing parts, you could shave a few pounds off of the completed trike by using pillow block bearings with an aluminum shell, but these will cost you more.

The bolts will be cut down to the minimum length needed and welded directly to the frame instead of being placed through the frame tubing. This mounting system saves your frame tubing from being crushed by the force of the bolts and it also saves weight. You also save time by not needing to drill through any of the rear frame tubing.

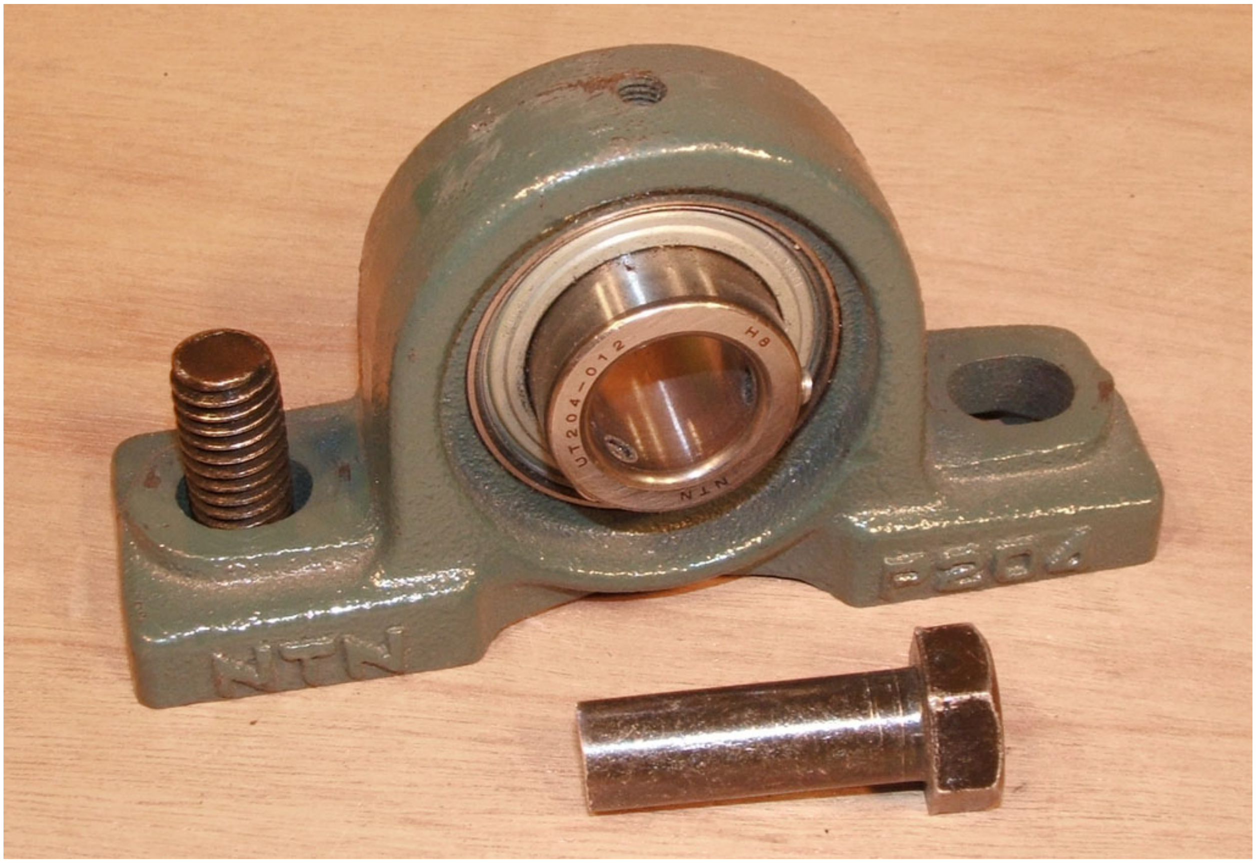


Figure 35 - Cutting down the bearing bolts

As shown in Figure 35, cut the bolts down so there is only enough thread sticking up past the bearing hole to properly install the nut and washer. Try to cut the bolts off as square as you can so they stand straight up when placed on a flat surface. This will make welding them to the frame a lot easier.

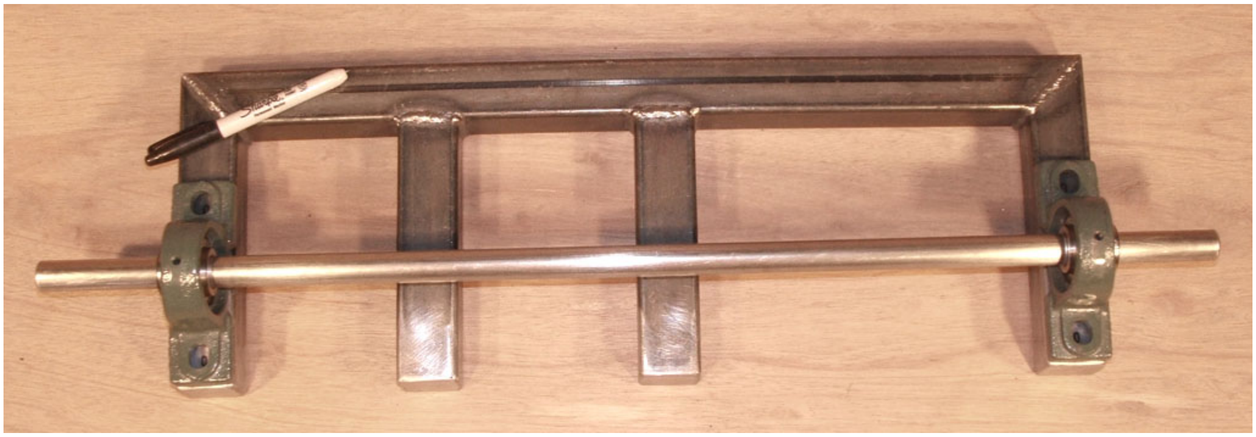


Figure 36 - Aligning the outer axle bearings

Remember when I mentioned earlier that having an extra length of axle would come in handy? Figure 36 shows how a length of axle can be used to align the two outer pillow block bearing on the frame so that the rear wheels are tracking perfectly. By using the axle to hold the two bearings in place while you mark the bolt locations on the frame, the alignment is pretty much guaranteed, and solves any alignment issues that may have been introduced due to heat distortion. Place each pillow block at the ends of the two axle support tubes as shown in Figure 36, and then use a marker to mark the position where the bolts are to be welded. Try to keep the marker perfectly vertical when you mark the bolt positions.

✓ Builders Tip

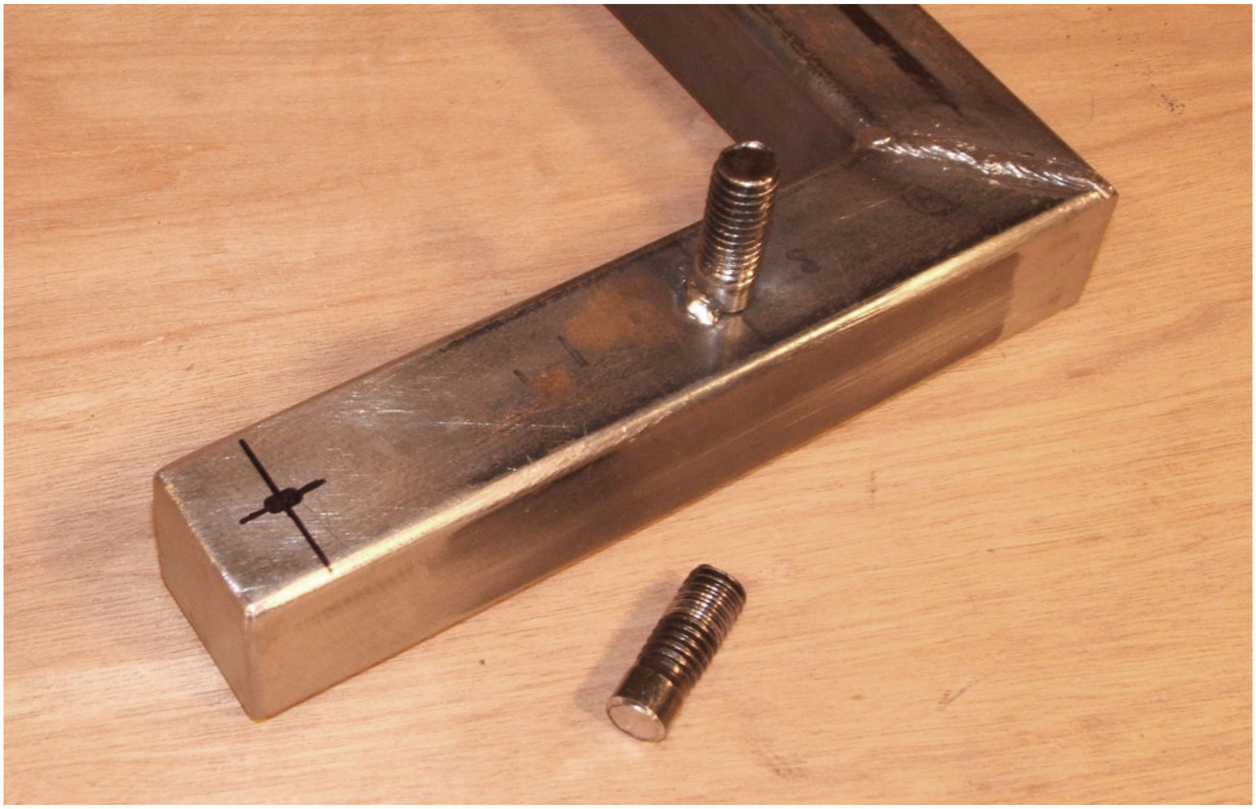


Figure 37 - Welding the bolt stubs to the frame

Once you have the two outer bearing bolt locations marked, tack weld the bolt stubs in place as shown in Figure 37. A single tack weld is first made so you can check the vertical position of the bolt stub, tapping it with a hammer if necessary to straighten it up. Tack weld all four of the outer bearing support bolt stubs to the frame. If you sometimes wander with your welder, then place some tape over the bolt threads to protect them from accidental damage.

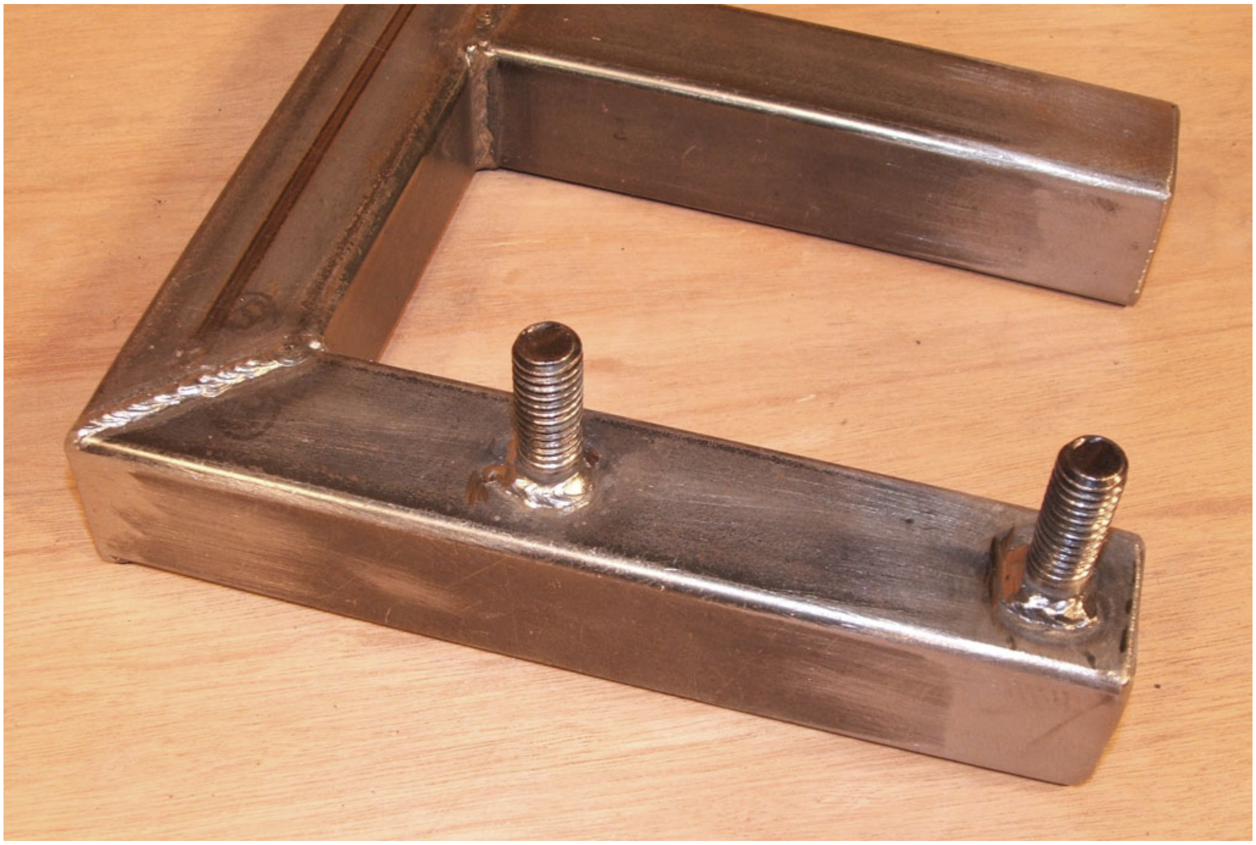


Figure 38 - Outer bolt stubs completely welded

Once you have the bolt stubs tack welded as vertically as possible on the rear frame, weld all the way around the bolts as shown in Figure 38. If your welds are a bit heavy, grind them down slightly so that the pillow block bearings fit flat on the frame tubing. There is a hollow space under the bearing casings, so the welded area should have enough room to allow the bearing base to sit flush onto the frame tubing.

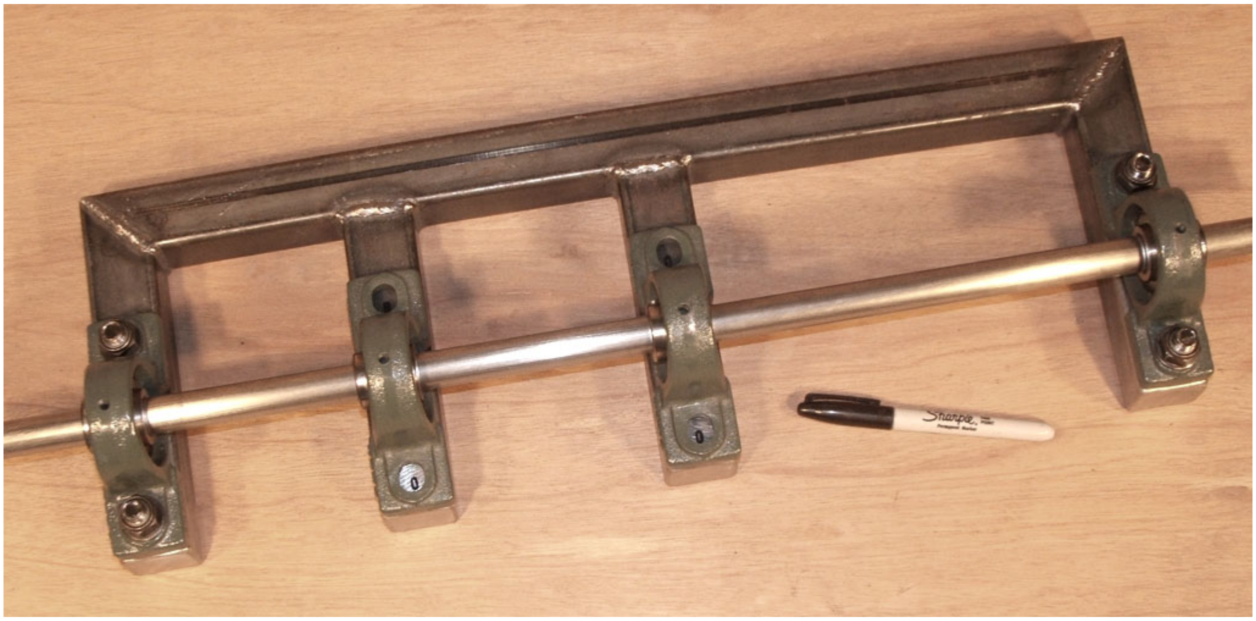


Figure 39 - Centering the two inner bearings

With the two outer bearings fastened to the frame, you can now determine the perfect placement of the inner two bearings by installing the axle length as shown in Figure 39. Now all four bearings will be perfectly aligned with each other, regardless of any frame distortions due to welding heat. Mark the bolt locations just as you did earlier on the outer two bearings.

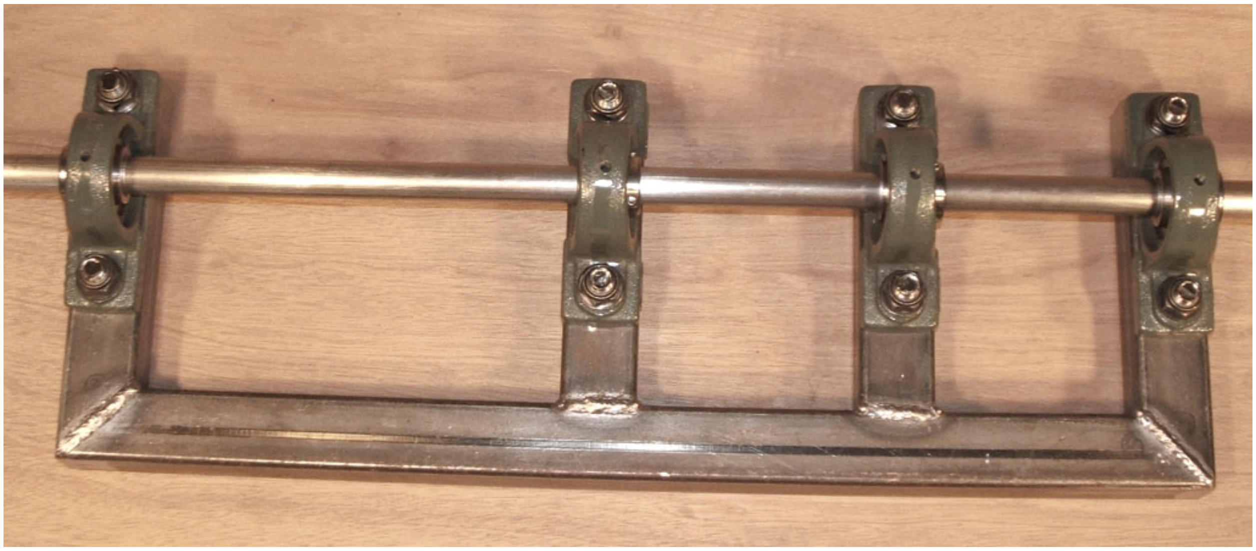


Figure 40 - All bearings secured to the frame

With all four pillow block bearings secured to the frame by the completely welded bolt stubs (Figure 40), you can now slide out the solid axle and insert the two rear wheel axles. Keep the long axle around until you are completely done this project because you will use it one more time when you put everything together after painting. You can now install the rear wheel axles and trim them to the correct length. This is shown later in Figure 75.

REAR SUSPENSION SWING ARM

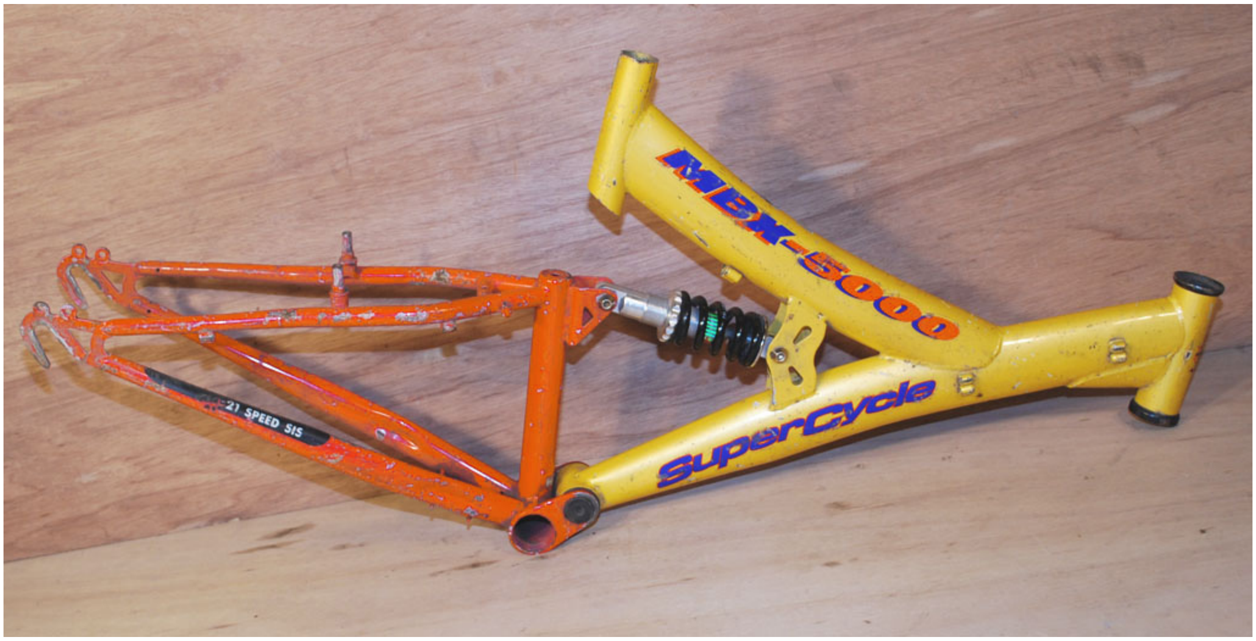


Figure 41 - Salvaging the suspension parts from an old frame

The Aurora Trike has rear suspension that works the same way as the suspension on a typical mountain bike - a pivot and a suspension spring to help take up shock from bumps in the road. In fact, all of the suspension parts can be salvaged from an old or new frame like the one shown in Figure 41. You will need the actual suspension spring, the pivot bearings and mounting hardware, as well as the mounting hardware that holds the suspension spring to the frame. There are many different styles of mountain bike suspension frames, but all of them can be used for parts as long as they are made of steel, so don't be too fussy when looking for a frame to cut up. As long as the spring and pivot seem to be in working order, you will be able to make use of the suspension parts.

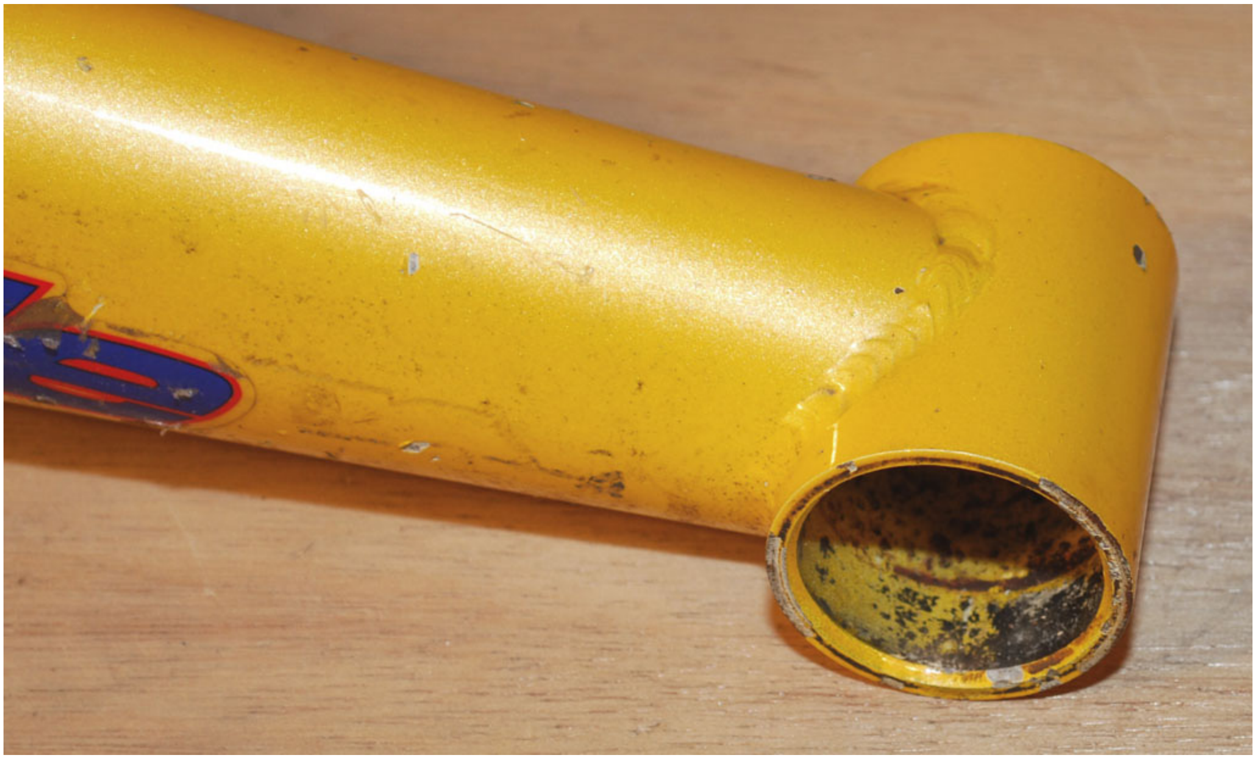


Figure 42 - The swing arm pivot tube needs to be cut from the frame

The small round tube shown in Figure 42 is the suspension pivot tube that contains the brass or plastic bushings that allow the rear triangle swing arm to move up and down in response to rough terrain. This tube may look different depending on the style of frame you are using for parts, but generally, the bearing components are all the same - a tube that has a pair of press fit brass or plastic bushings and a main pin to hold the swing arm in place. Remove the swing arm and then tap out the bearings using a rod or screwdriver to leave the pivot tube empty as shown in Figure 42.

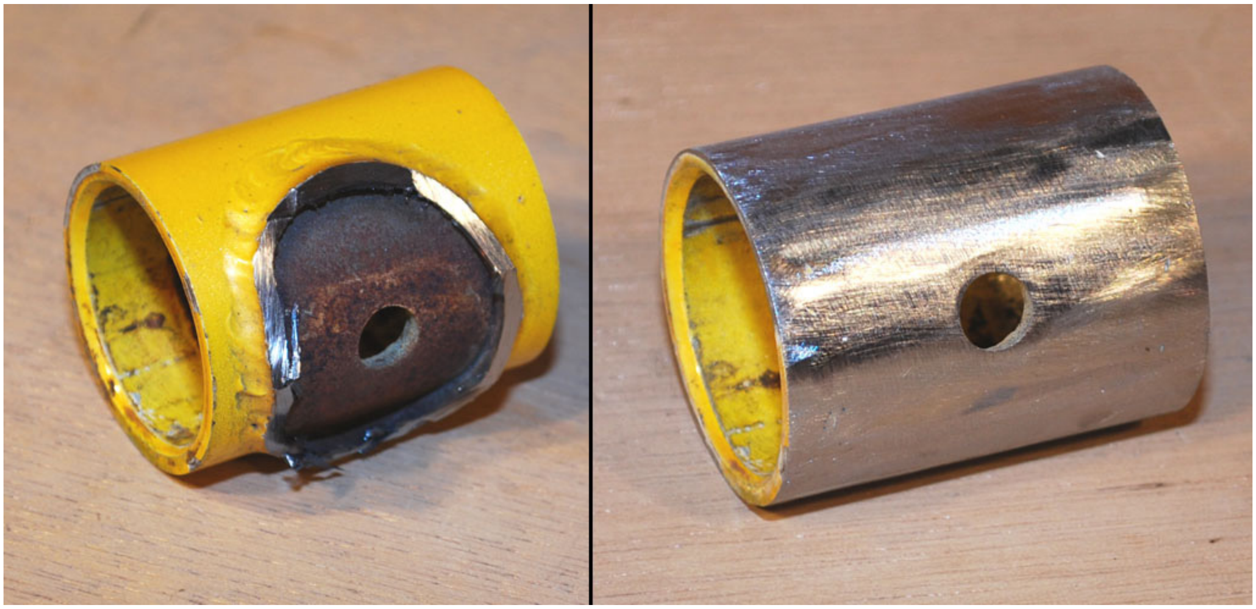


Figure 43 - Removing the pivot tube from the frame

To remove the suspension pivot tube form the frame, first cut along the weld using a zip disc or hacksaw to remove the part as shown in Figure 43 (left side), taking care not to cut into the pivot tube. Do this operation with the bearings removed from the tube as the heat from the grinder cutting could melt the plastic bearings. The right side of Figure 43 shows the suspension pivot tube after a little fork with the sanding disc that cleans up any of the excess tubing and paint from the surface.

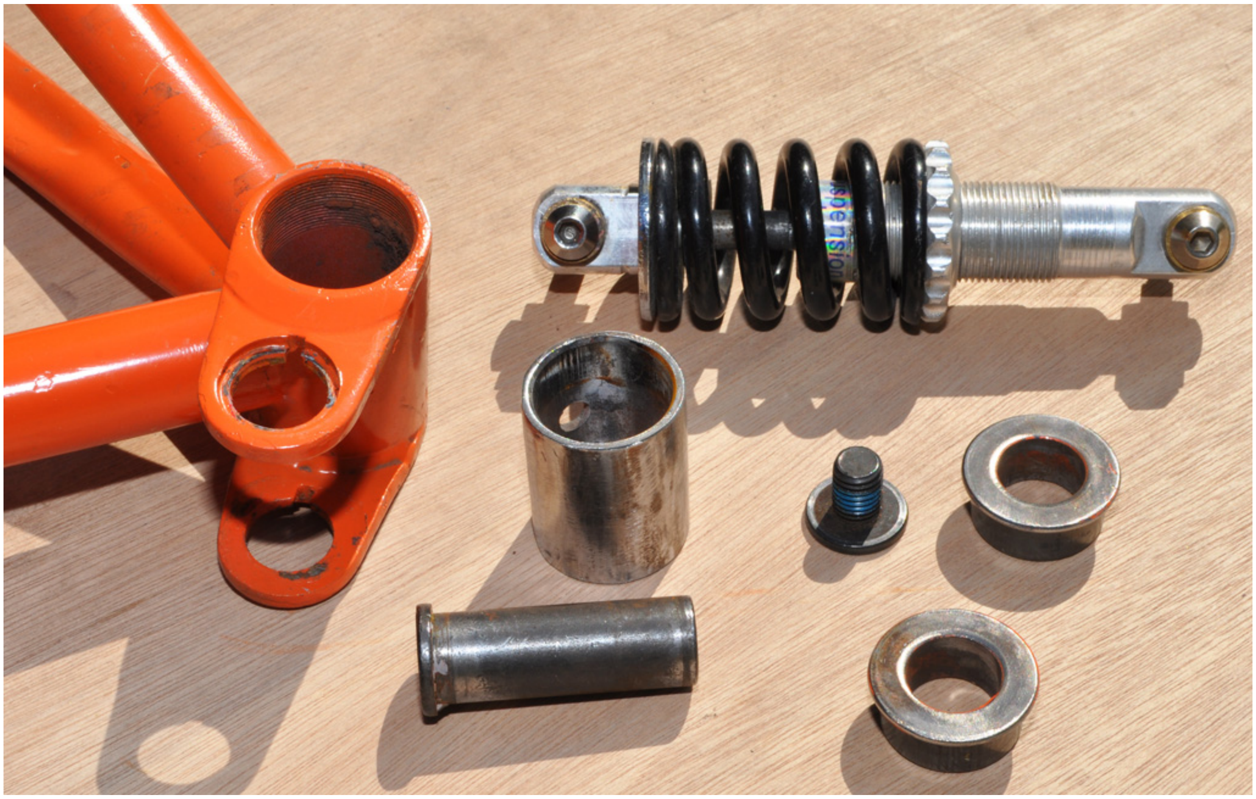


Figure 44 - The bare suspension pivot tube along with the bearing hardware

The suspension pivot tube is shown in Figure 44 along with all of the bearing hardware, suspension spring, and the mounting tabs still attached to the rear triangle. Since you now have the main suspension pivot tube removed from the frame, you need to remove the other part of the hardware that attached the rear triangle to the bearing hardware. In my frame shown in Figure 44. The rear triangle hardware is just a pair of mounting tabs that hold the main pin through the bearings. Your hardware may differ, but either way, you can still remove it from the frame. Also, ensure that the rear triangle hardware is steel, not aluminum or you will not be able to weld it to your new frame.

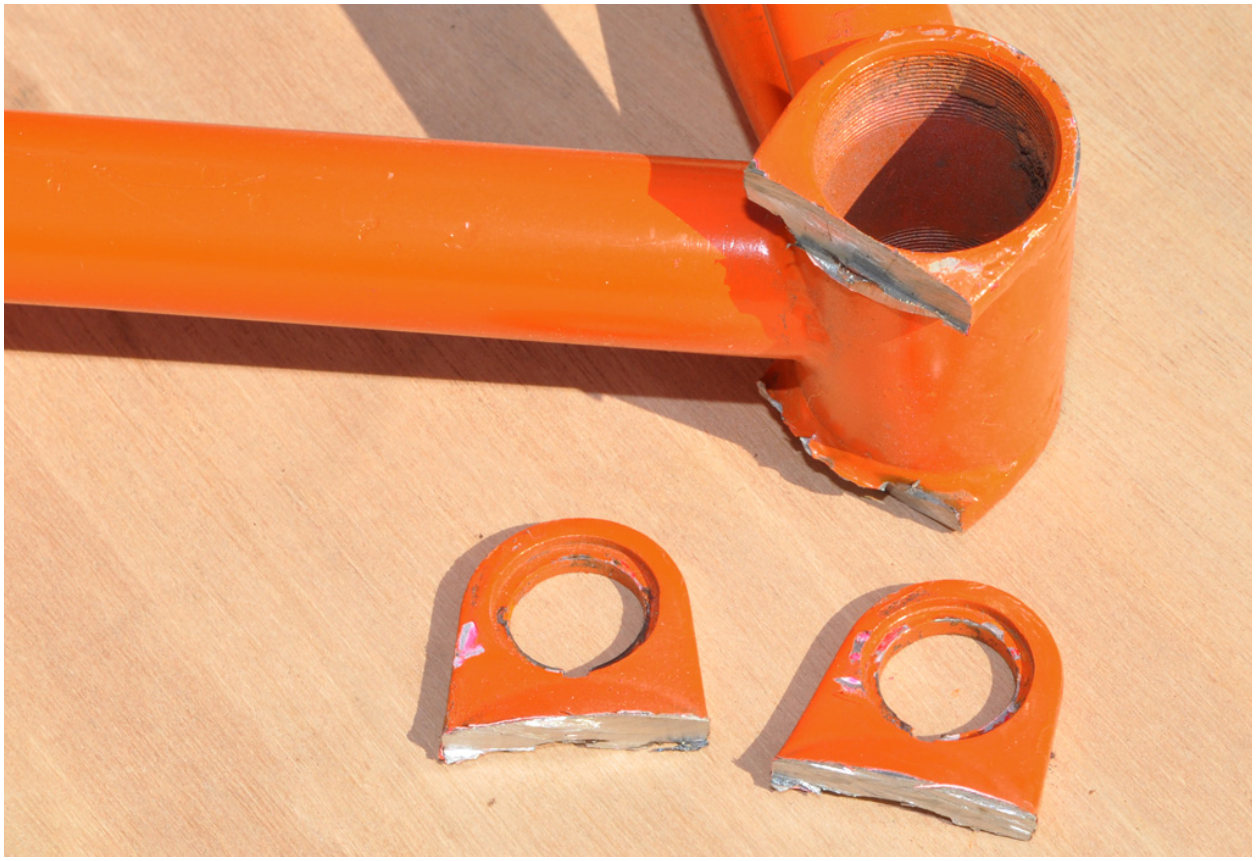


Figure 45 - Removing the rear triangle suspension support hardware

If your rear triangle has a pair of mounting tabs like the ones shown in Figure 45, then cut them away from the other frame tubing, including as much material on the tabs as possible. Don't worry about the bottom bracket if it looks like the one shown in Figure 45 because it will not be used for this project. Read ahead to see how the suspension on the Aurora Trike works if your hardware is significantly different than what is shown here. There are always ways to adapt to the parts you have on hand.

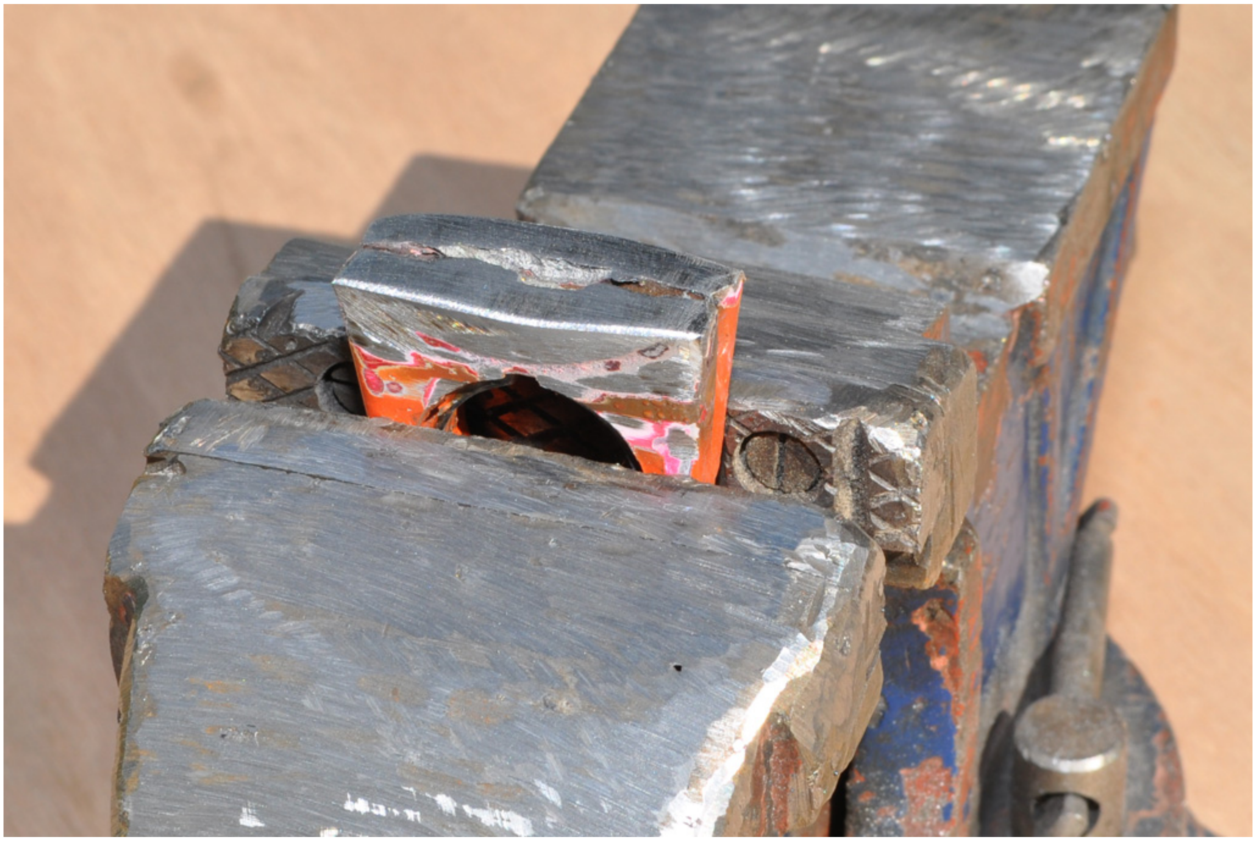


Figure 46 - Grinding the two parts so they are identical in size

Once you have cut the rear triangle support hardware from the frame, place the two parts in a vice using the center hole as a guide to align them as shown in Figure 46. Grind the area that was cut so that both parts end up exactly the same size.

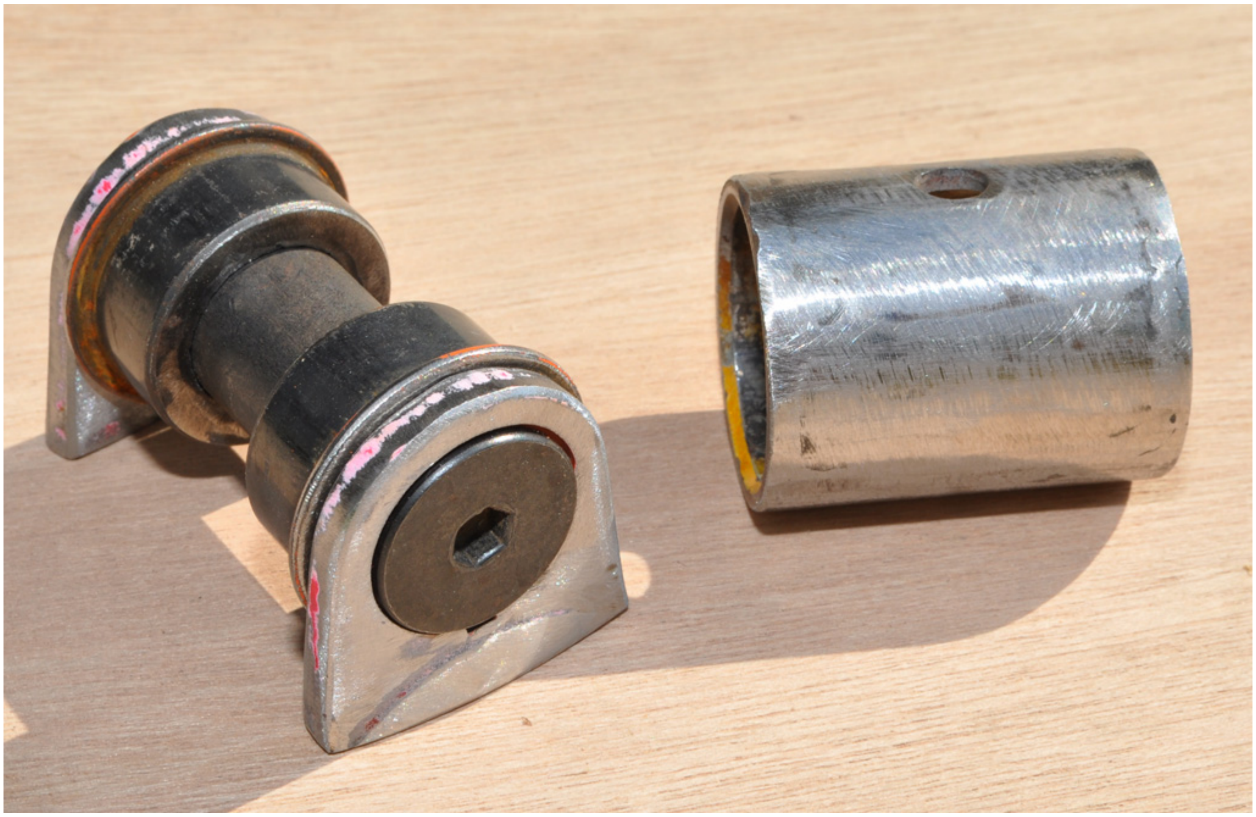
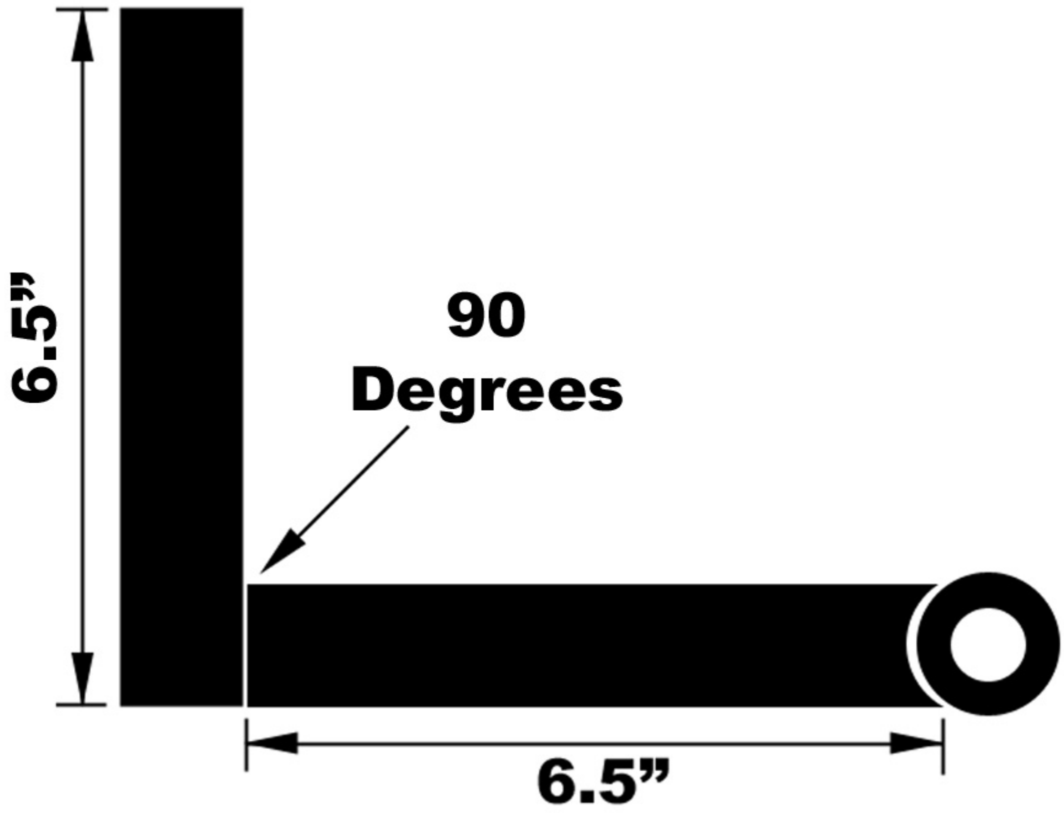


Figure 47 - The suspension pivot parts can now be used on your project

Your suspension pivot hardware may not look exactly like the components shown in Figure 47, but they will still be easy to adapt to the square tube from the Aurora. You could even create your own pivot hardware using a pair of half inch brass bushings, a bolt and some round tubing to press fit the bushings, but if you can salvage the hardware from a bicycle frame, it will be less work.

Builders Tip



Drawing 2 - The rear suspension swing arm dimensions

The rear swing arm assembly is shown in Drawing 2. Take note of the placement of the two 6.5 inch tubes at the 90 degree joint - the tube that carries the pivot tube is placed against the other tube.

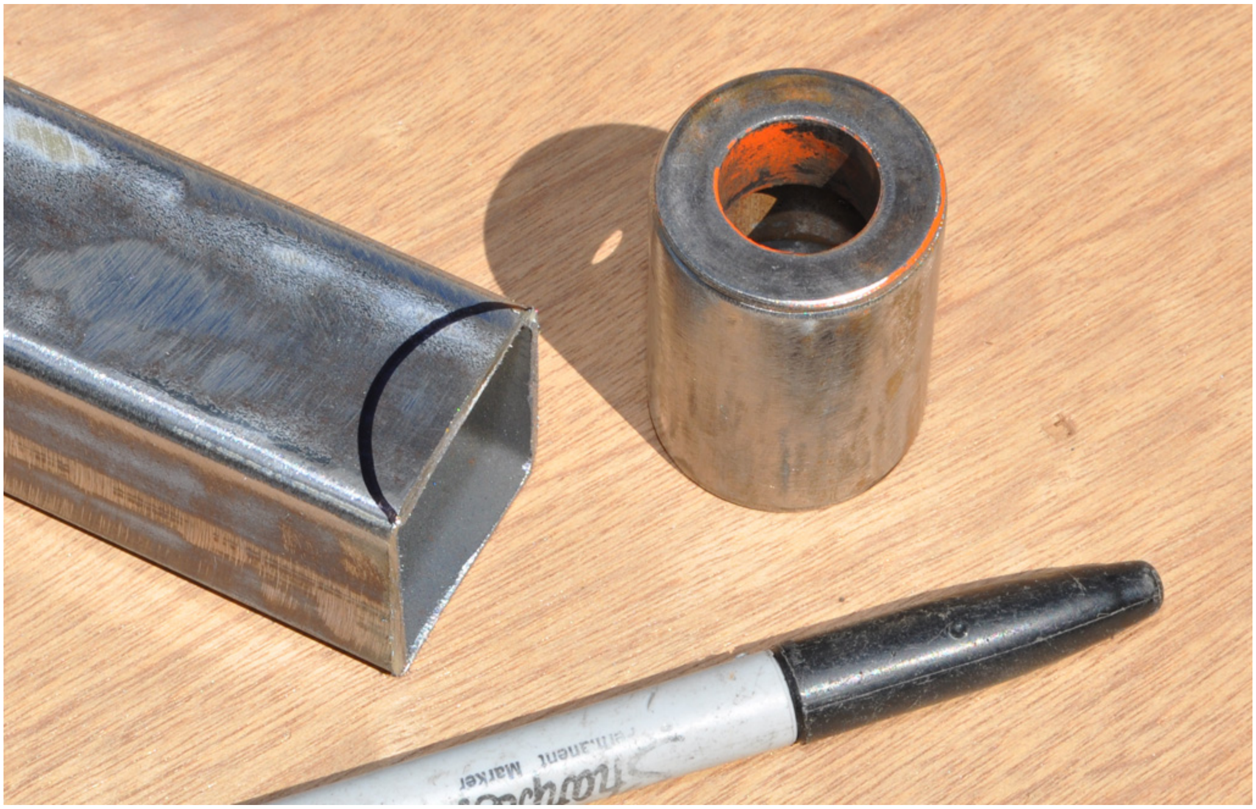


Figure 48 - Marking the end of the rear boom tube for the fish-mouth cut

The suspension pivot tube will mount to the end of one of the 6.5 inch long rear swing arm tubes as shown in Drawing 2, so a fish-mouth cut must be made so the parts can be welded together. Looking ahead to Figure 83, you can see a close view of how the pivot tube will be installed so that the rear portion of the trike can move up and down in response to the bumps in the road. The resulting suspension system is basically the same on the Aurora as it is on any suspension bicycle.

Place the suspension pivot tube on each side of the swing arm tube so you can trace a line that will meet from corner to corner in an arc as shown in Figure 48. Remember, these cuts are made on the sides of the frame tubing, not the top and bottom. Looking ahead at Figure 83 shows this in more detail.

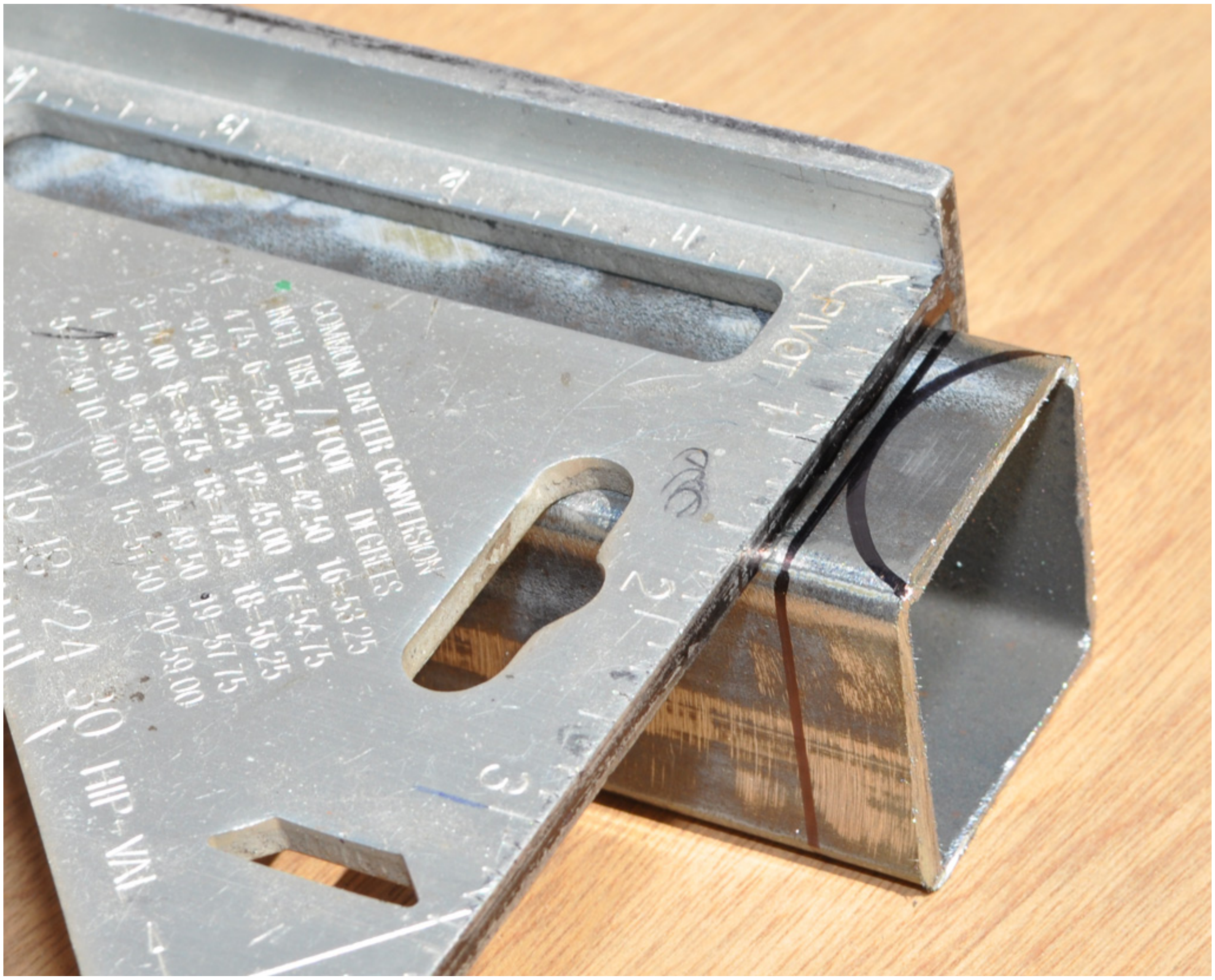


Figure 49 - Transfer the fish-mouth to the other side of the tube

To ensure that the fish-mouth will be the same on each side of the rear swing arm tube, use a square to transfer a line around the tubing as shown in Figure 49 so you can mark the depth equally on each side of the tube. This should be done anytime an equal cut has to be made on opposing sides of a square tube.

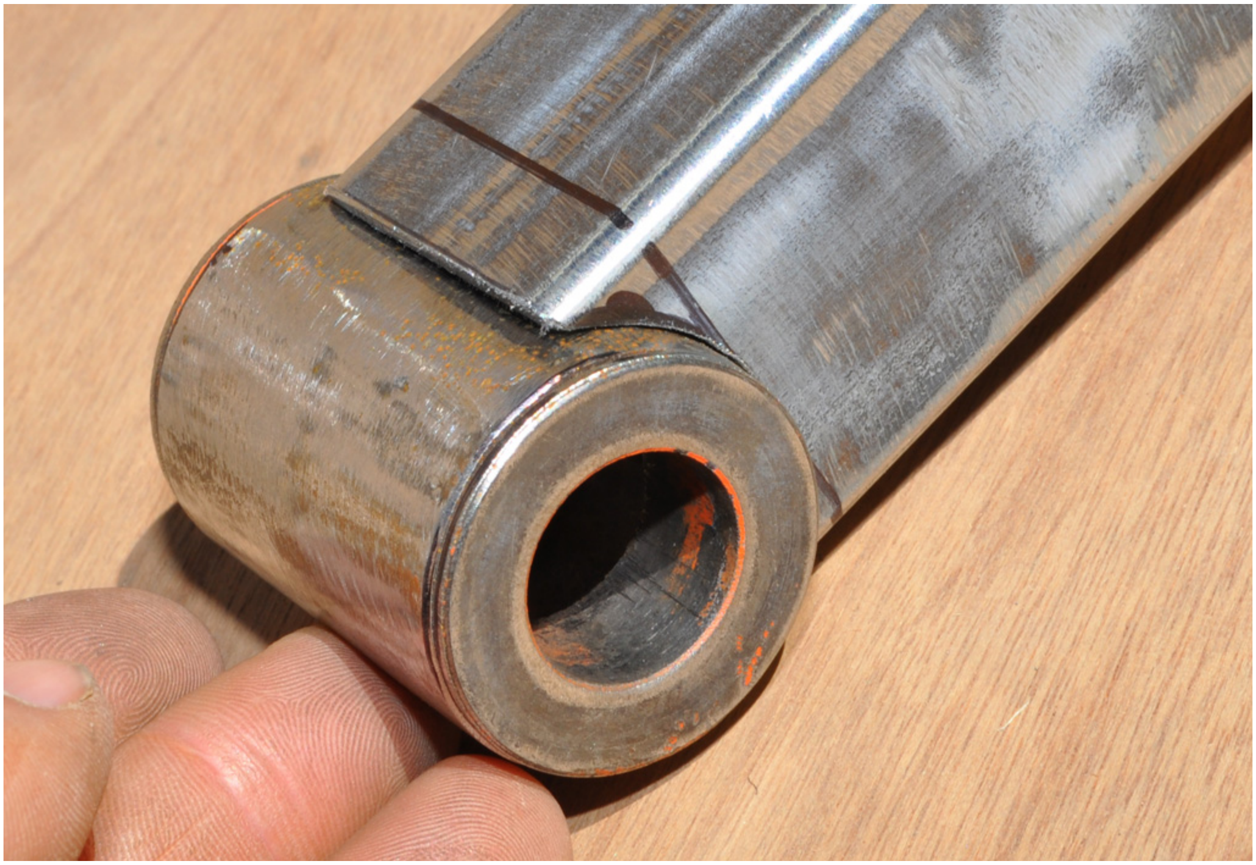


Figure 50 - Test fitting the suspension tube into the fish-mouth cutout

The suspension pivot tube should fit neatly into the fish-mouth cut made in the end of the swing arm tube as shown in Figure 50. It is important that the pivot tube be installed at 90 degrees to the square tube so that the two sections of the frame connected by the pivot will be in line with each other.

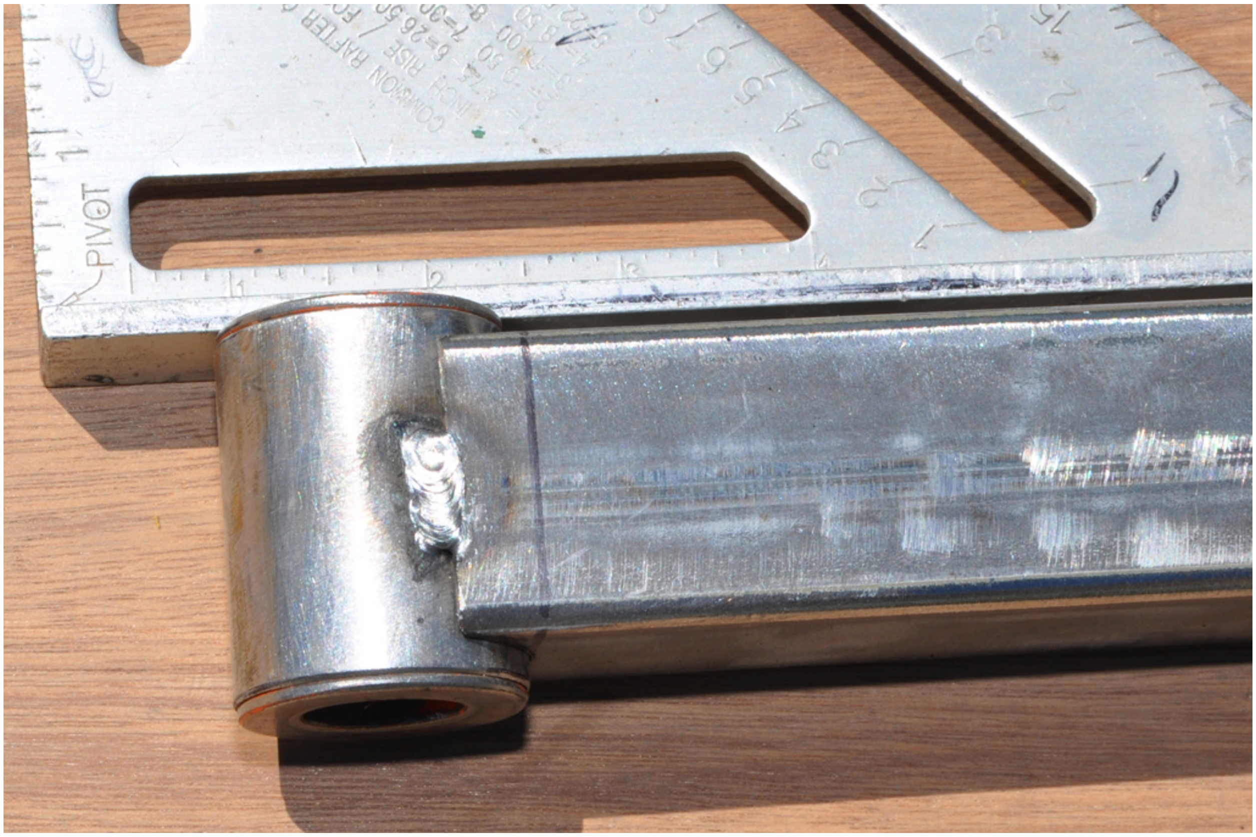


Figure 51 - Checking the alignment with the frame tubing

Place a single tack weld on the joint as shown in Figure 51 and then verify that the suspension pivot tube is at 90 degrees to the swing arm tube by placing a flat edge on the suspension tube as shown in Figure 51. The flat straight edge should line up parallel to the swing arm tubing if you place it flat on either end of the suspension pivot tube.

Tap the part with a hammer to make any necessary corrections before making any more welds on the joint. Also, ensure that you remove any plastic bearing parts from the suspension tube while welding. My bearings are made of brass, so it was ok to have them installed during the welding process.

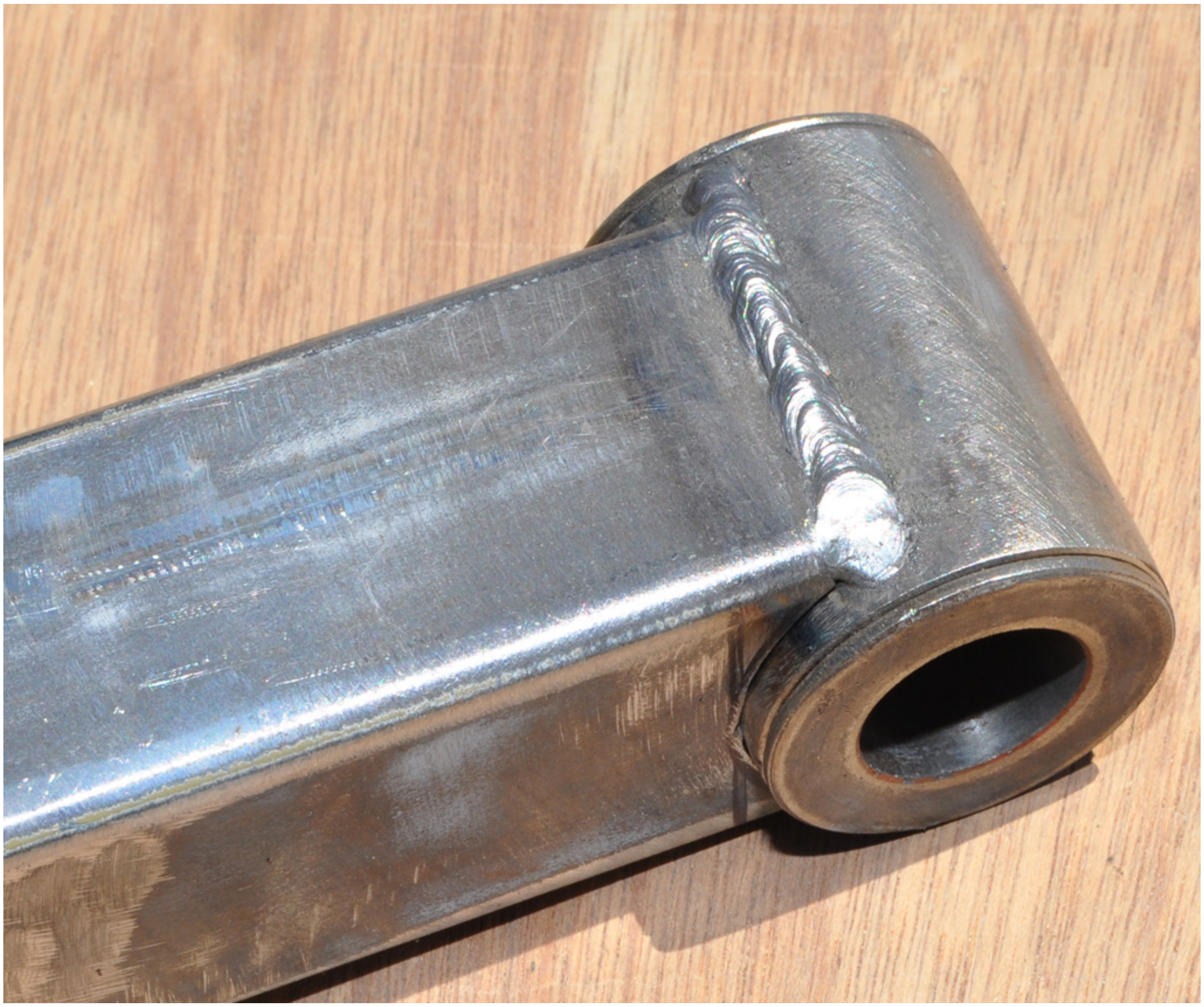


Figure 52 - Welding the top of the pivot tube joint

Like all of the other welding to be done, order of operations is important to minimize distortion from welding heat. With the suspension pivot tube aligned and tack welded on one side, run the first bead of weld across the top of the joint as shown in Figure 52. Weld the opposite side next, which will help minimize any side-to-side distortions that may occur when the sides of the joint are welded.

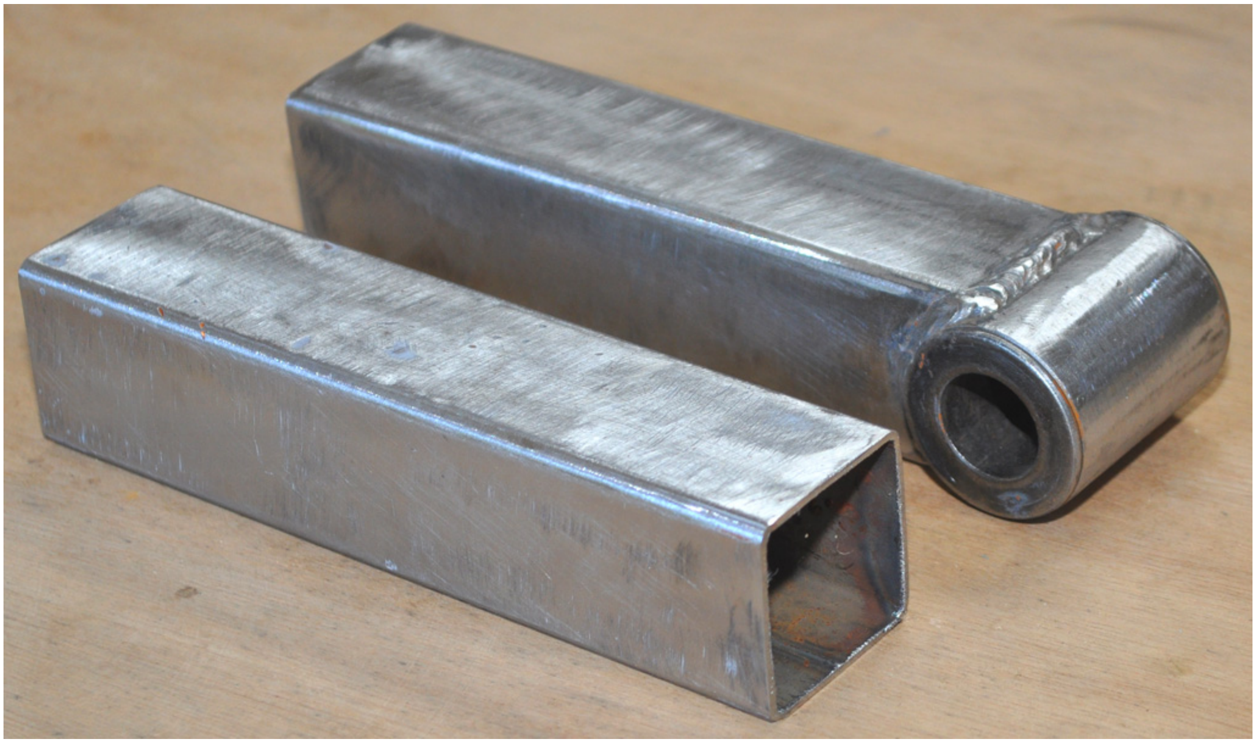


Figure 53 - The pivot tube fully welded

Now, you have a pair of 6.5 inch long tubes as shown in Figure 53, with one of them having the suspension pivot tube welded to one end. These two tubes will now be welded together to form a 90 degree angle.

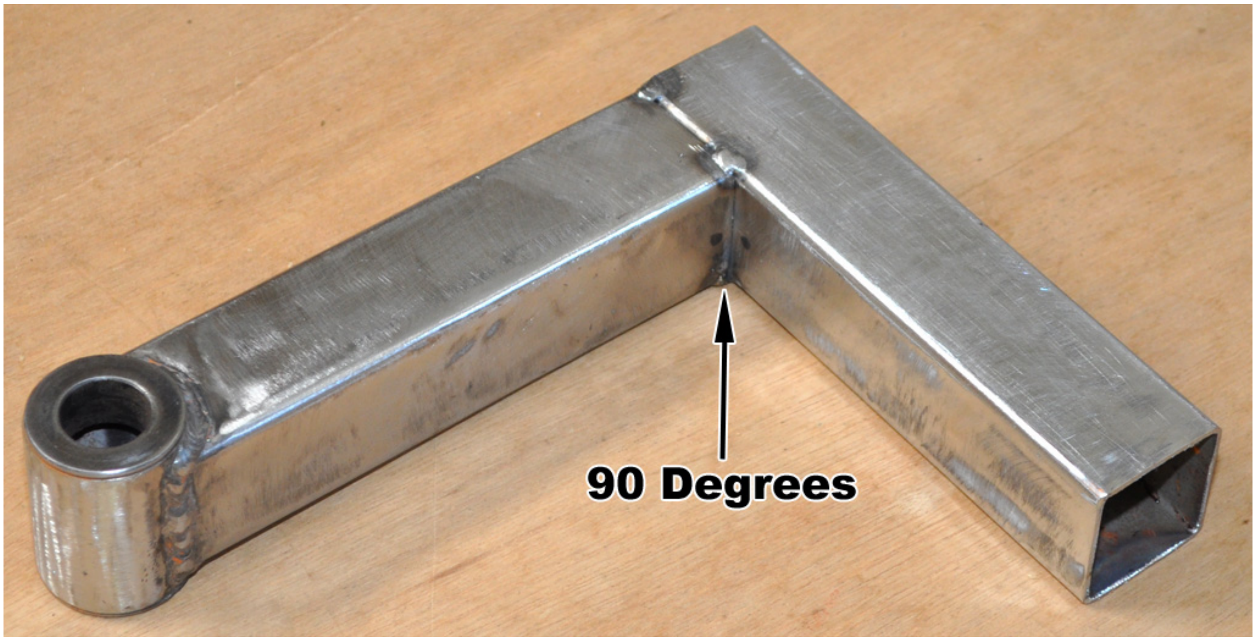


Figure 54 - Welding the swing arm tubes together

Take not of the position of each tube as shown in Figure 54. The tube with the pivot welded to one end meets the wall of the other tube, not the other way around. If you can see right through the open 6 inch tube, then you have them welded together properly. Tack weld the tubes at a 90 degree angle as shown in Figure 54. To keep both tubes aligned to each other, another flat tube or angle iron can be clamped in place to hold them for welding - this process can be seen in Figure 60.

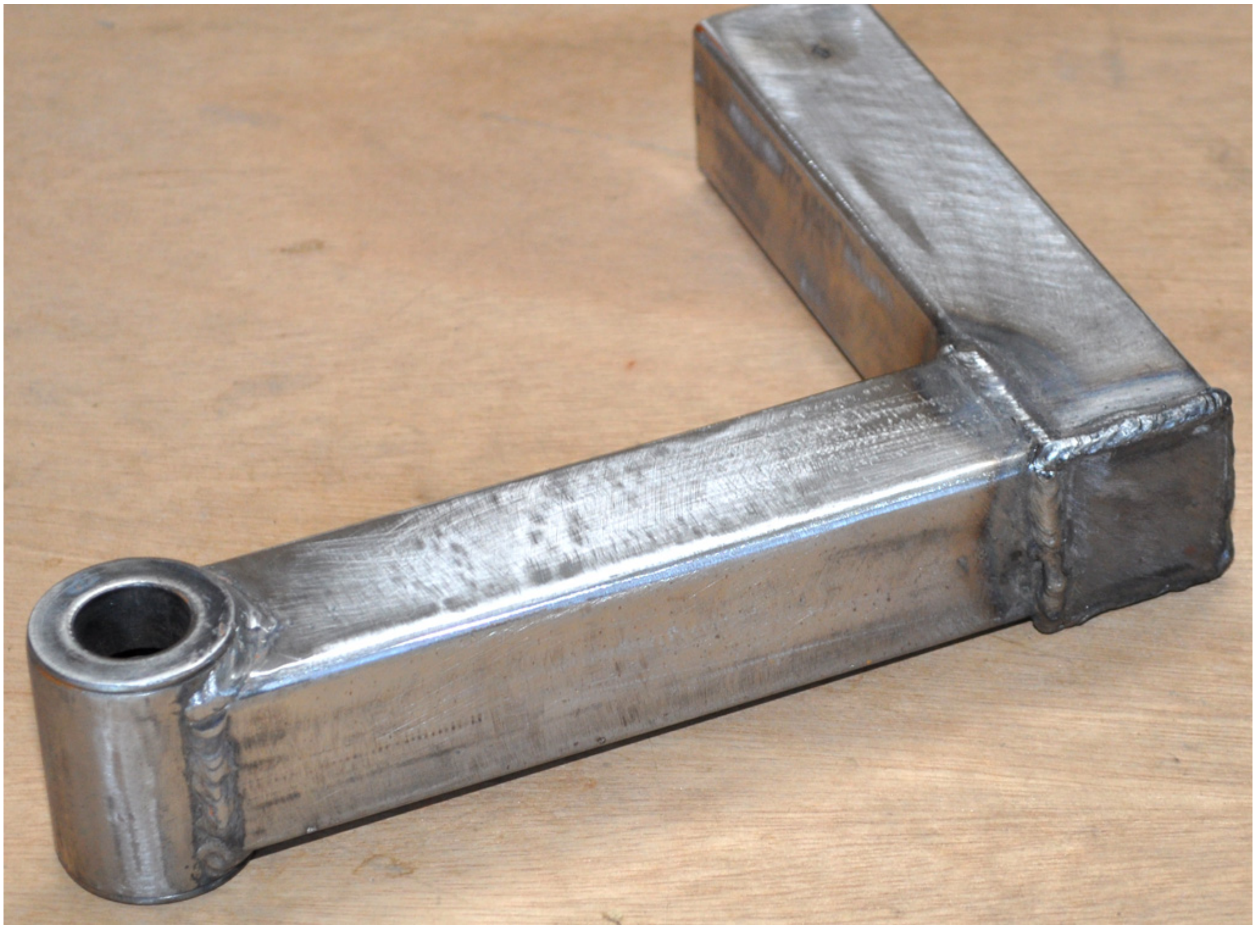


Figure 55 - Capping the lower open end of the tube

Just as you capped the axle support tubes earlier, you will need to cap the lower open end of the swing arm tube as shown in Figure 55. The cap is placed on the open end where the 2 tubes form the 90 degree angle.

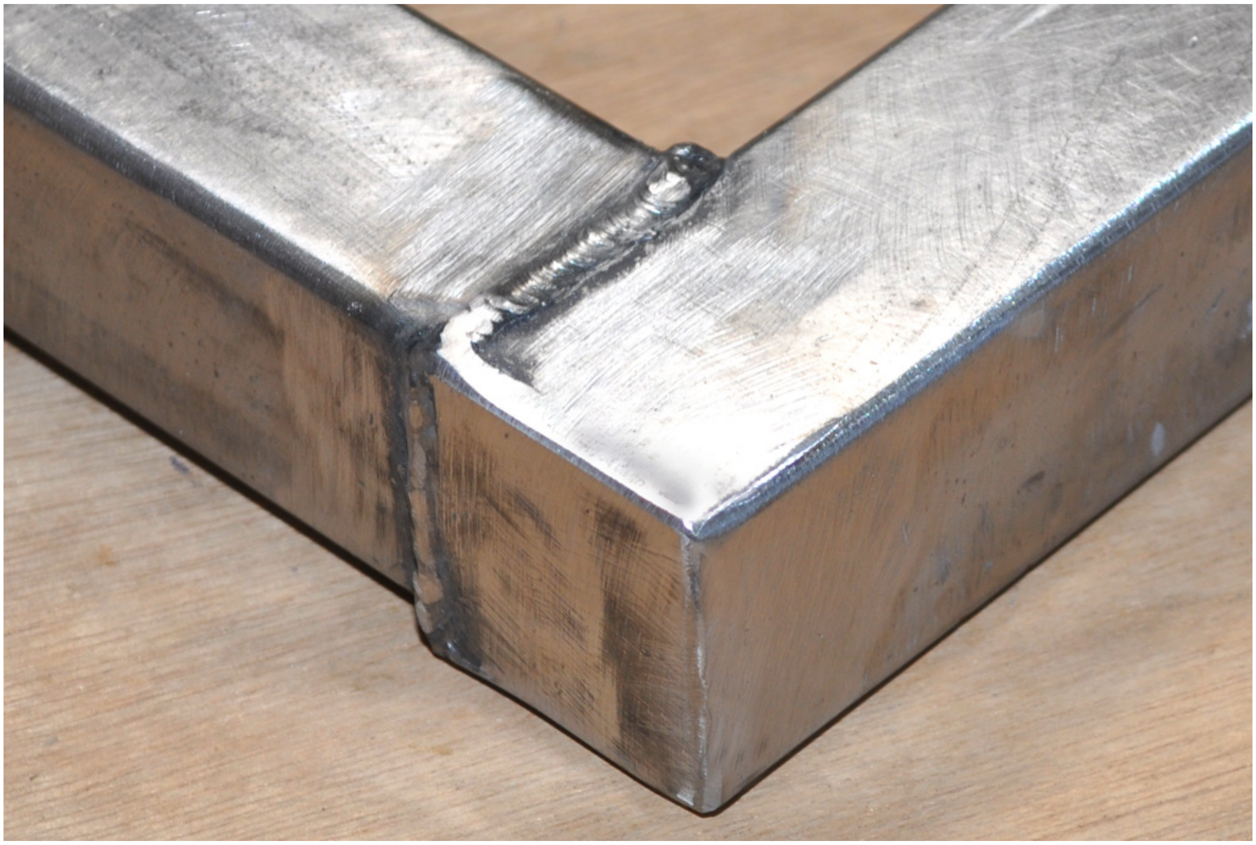
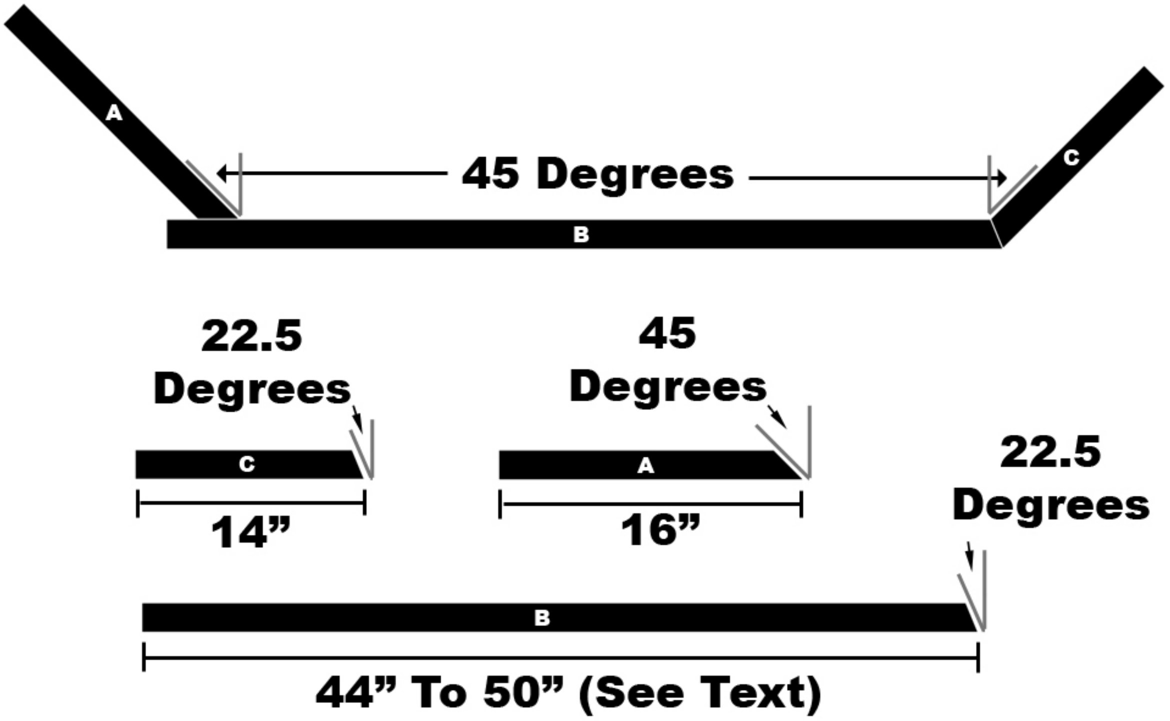


Figure 56 - The completed and ground tubing cap

Use your sanding disc to clean up the welding around the capped tube so that it looks seamless as shown in Figure 56. If you are wondering why a 45 degree joint wasn't used on these two tubes, it's because this method of joining them makes them stronger by the addition of the cap. Since this part will be under a decent amount of stress, strength is important.

BUILDING THE MAIN FRAME



Drawing 3 - The main frame dimensions

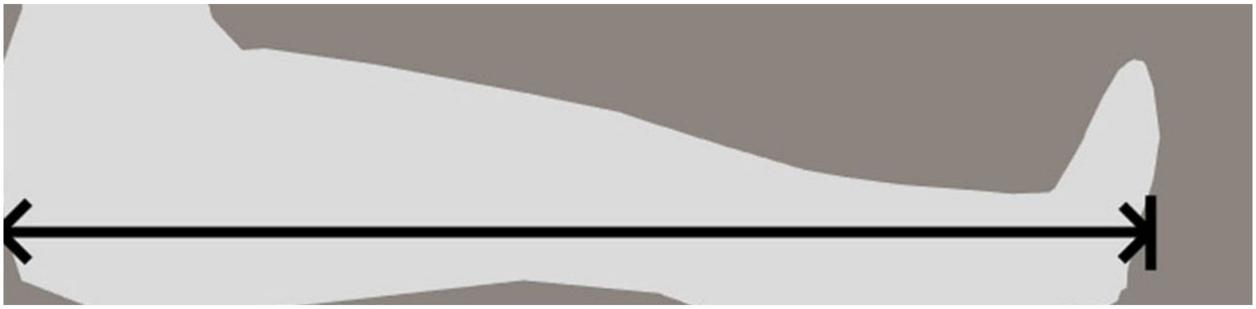
The Aurora Trike main frame is made up of three different 1.5 inch square tubes as shown in Drawing 3. The main boom tube (B) connects all of the other tubes to the frame and it also carries the head tube and rear suspension pivot. This main boom (B) runs parallel to the ground and also joins the rear seat tube (A) and the front boom (C) to form the shape of the frame. To see how the actual frame relates to the tubing shown in Drawing 3, have a look ahead to Figure 64.

The main section of the Aurora frame is basically a cradle with tubes placed at 135 degrees at each end. In Drawing 3, the angles of the frame tubes are shown as 45 degrees because they are taken from a 90 degree point off the main boom (B). You can see why this is done by referring to the rear seat tube (A) in Drawing 3, which would be cut by drawing a 45 degree angle from the side of the tube using a 45 degree square to mark a cut line. You can also fold a piece of paper in half to create a 45 degree template that can be used to mark the tube for cutting. The angle cuts on tube (B) and tube (C) are both made at 22.5 degrees so when they are placed together, forms the 45 degree angle.

Before making any cuts, you must decide how long to make the main frame boom tube (B), which will dictate how far ahead the adjustable bottom bracket can be moved to accommodate the tallest rider. Having the ability to slide the cranks along the main boom allows riders of most heights to set up the trike to their correct inseam, but there is no point having a longer trike than you really need. To calculate the length of the main boom, you will need the inseam measurement of the tallest

Builders Tip

rider that will be using the trike. To calculate “recumbent inseam”, have the tallest rider sit with his or her back against a wall as shown in Drawing 4 and then measure the distance from the wall to the underside of his or her foot while wearing shoes.



Drawing 4 – Measuring leg length or “recumbent inseam”

The measurement from the wall to the underside of the tallest rider’s shoe is what I call “recumbent inseam”. This length will be used to calculate the length of the main boom tube (tube B) so that it isn’t longer than necessary. Actually, the length that you will cut the main boom is the same as the length you acquire from Drawing 4, which takes into account 2 inches of seat thickness and front wheel to crank overlap. My “recumbent inseam” measurement was exactly 44 inches, so I cut the main boom to the same length of 45 inches to allow for a little extra room just in case.

You will likely set your cranks to one length and leave them there, but if you think you may want to adjust them for a taller rider or possibly sell/lend your trike to someone else, then add a few inches to the boom to be safe; it will not affect your handling characteristics. A few extra inches of boom length will also allow you to try out alternative seat configurations such as a mesh seat, which will push the rider a few inches closer to the front of the trike as compared to a basic wood and foam seat.

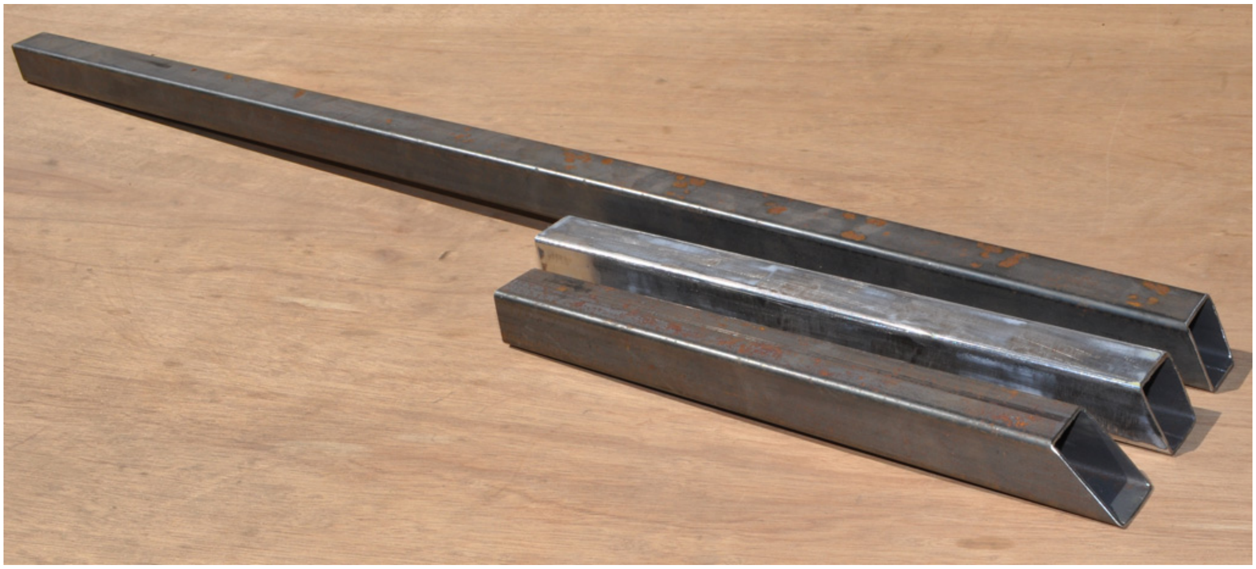


Figure 57 - Cutting the 3 main frame tubes as per Drawing 3

Once you have worked out the length of the main boom tube (B) using your recumbent inseam measurement, cut all three tubes based on Drawing 3. You will end up with the three main boom tubes as shown in Figure 57. Both tubes (B) and (C) have a 22.5 degree cut taken from the 90 degree end and tube (A) has a 45 degree cut as taken from the 90 degree end. If you do not have a 45 degree square or an adjustable angle finder, you can make a 45 degree template by folding a piece of paper in half and a 22.5 degree template by folding it over twice. The angle formed between the seat back tube (A) and the main boom tube (B) determines the angle of the seat, which will become 135 degrees (90 + 45) if you follow the angles given. You can certainly modify the seat angle if you like, but the angles given will offer a good balance of comfort and aerodynamics all around.

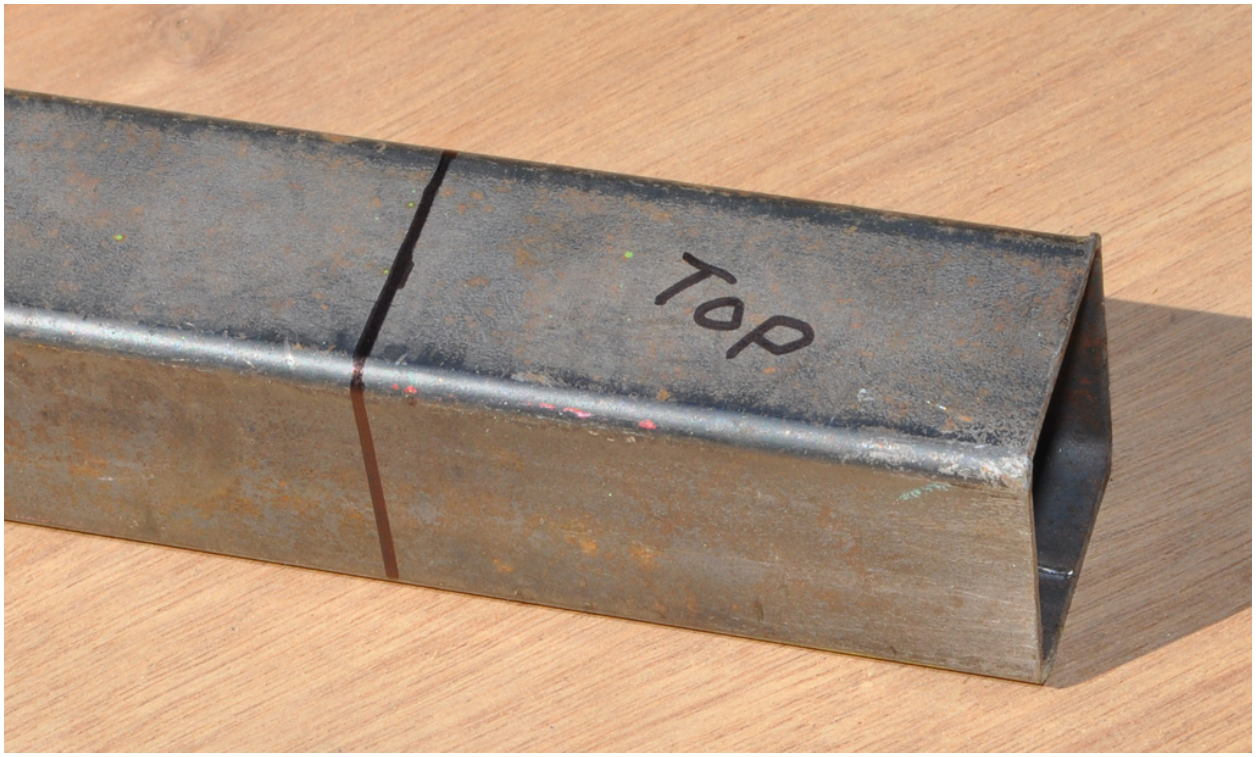


Figure 58 - Mark a line 3 inches from the rear of the main boom tube

There will be a 3 inch section of the main boom (B) extending past the joint at the rear seat boom (A), which can be seen in Drawing 3 and Figure 64. This extended section is where the suspension pivot will join the rear frame section and allows room for a small gusset that will strengthen the frame for heavier riders. As shown in Figure 58, mark a line taken 3 inches from the rear end (90 degree end) of the main boom tube. I always mark "top" on the side of my tubing that does not have the seam so it is on the underside of the frame. Sometimes you can see the seam after painting.

Builders Tip

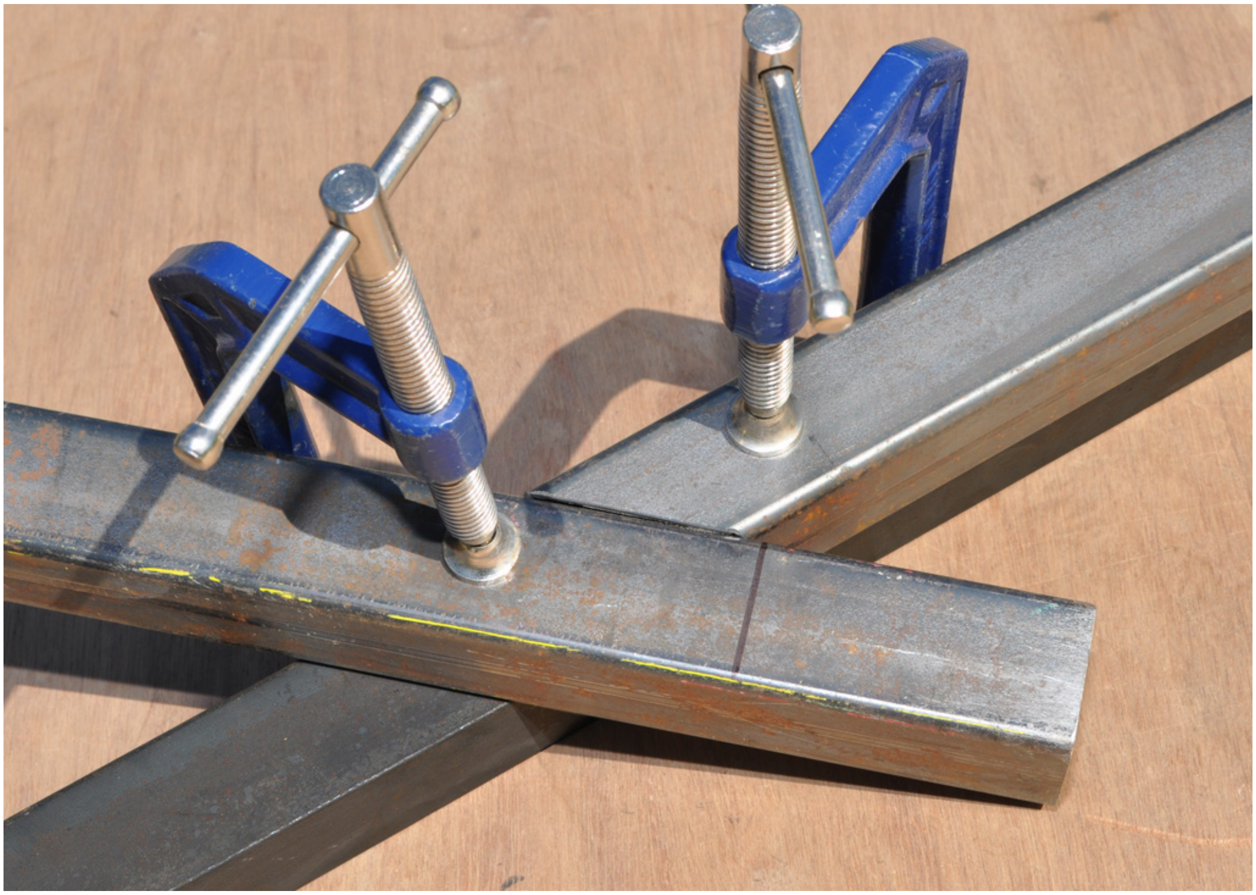


Figure 59 - Using a straight tube to align the frame for welding

The first two main frame tubes to join will be the main boom tube (B) and the seat back tube (A), forming the 135 degree seat angle. This tube is installed just ahead of the 3 inch line you marked in Figure 58 so that the 3 inch section will extend past the rear of the seat back tube. Use another section of 1.5 inch tubing or some thick angle iron to clamp the two tubes for welding as shown in Figure 59. With the guide tube and clamps in place, frame distortion will be eliminated, keeping the tubing perfect inline during the welding process.

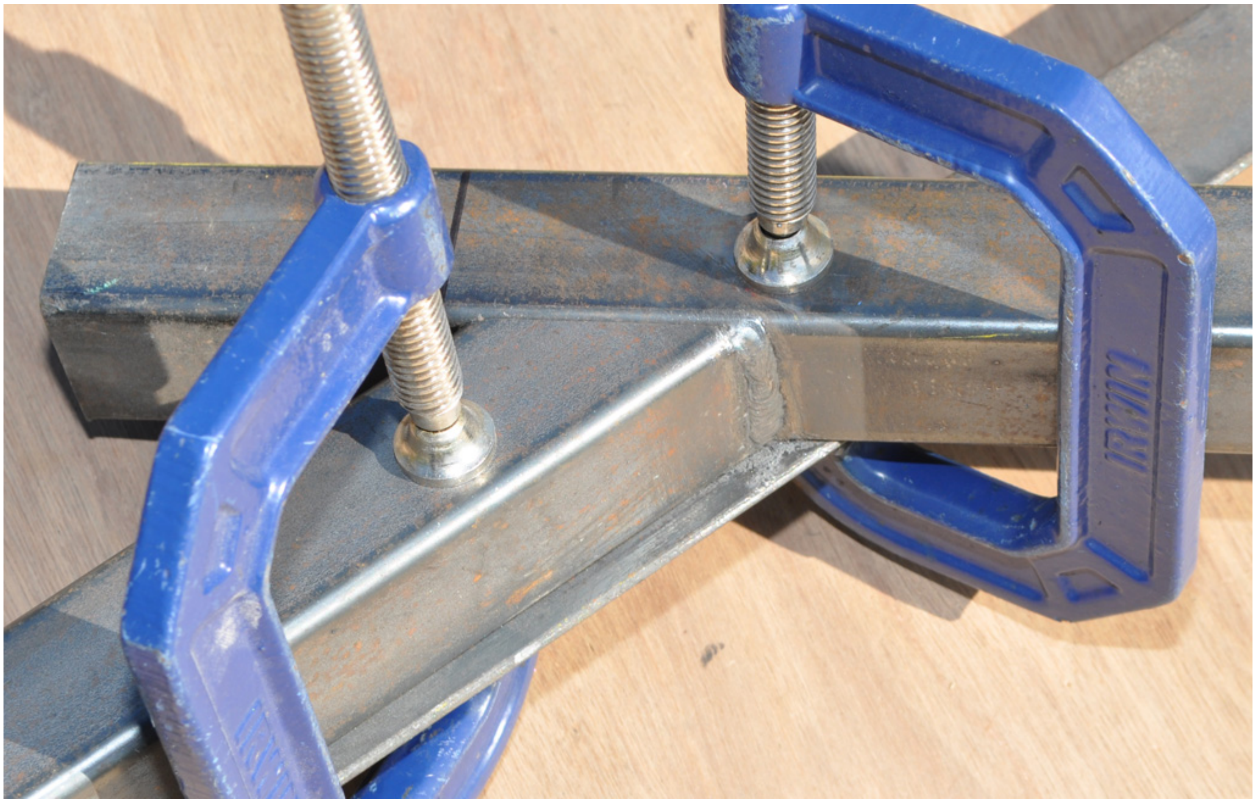


Figure 60 - Weld the top of the joint with the clamps installed

Using the usual order of welding, start with the top of the joint as shown in Figure 60 while the clamps are still holding the two tubes together. Keeping side-to-side distortion to a minimum is important so that the front end of the frame will be in line with the rear of the frame.

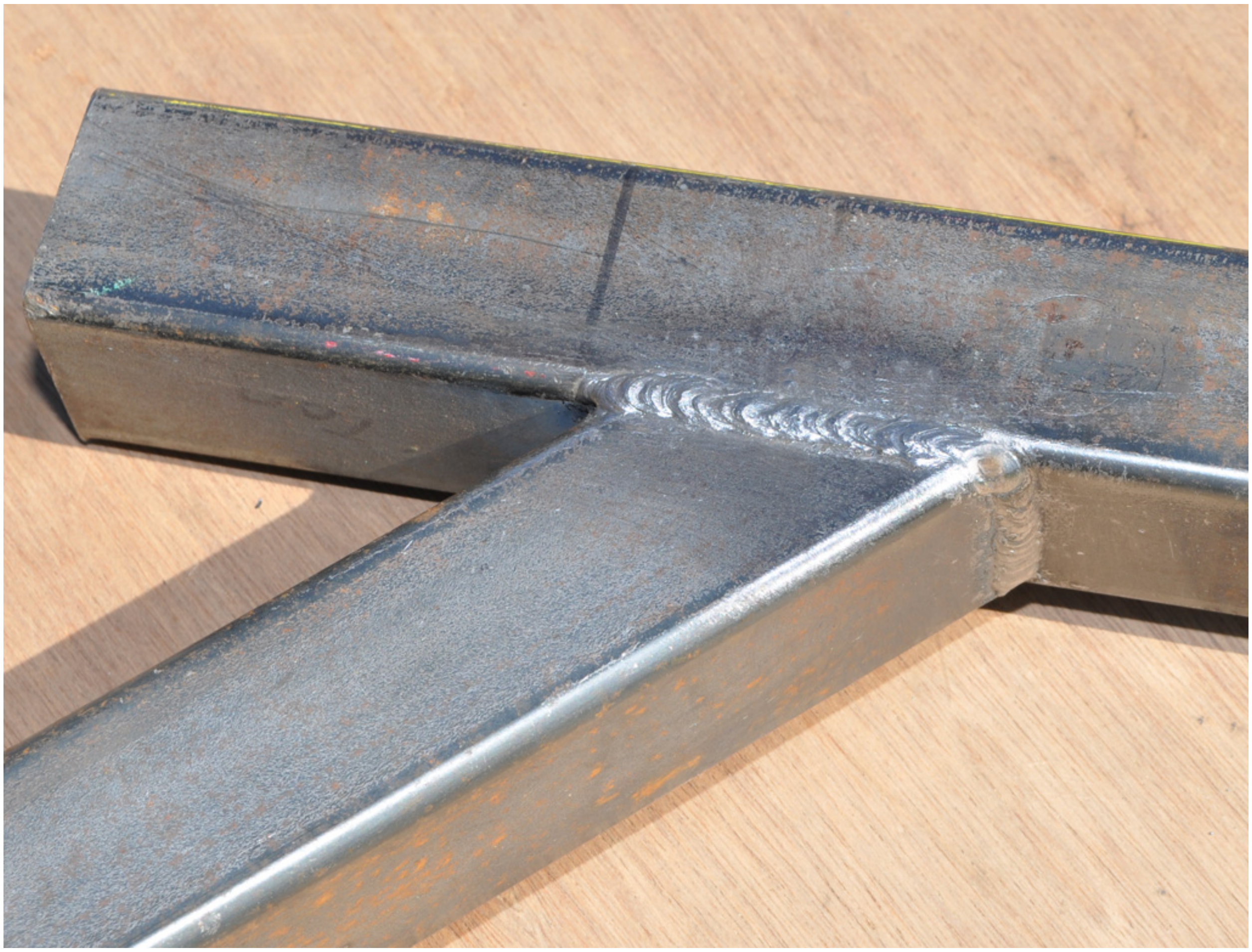


Figure 61 - Welding the two sides of the joint

With the clamp still installed, weld the open side of the joint and then remove the clamps to complete the other side of the joint as shown in Figure 61. The rear of the joint is not welded because there will be a gusset installed at that point later. Welding the rear joint would also be very difficult due to the steep angle.

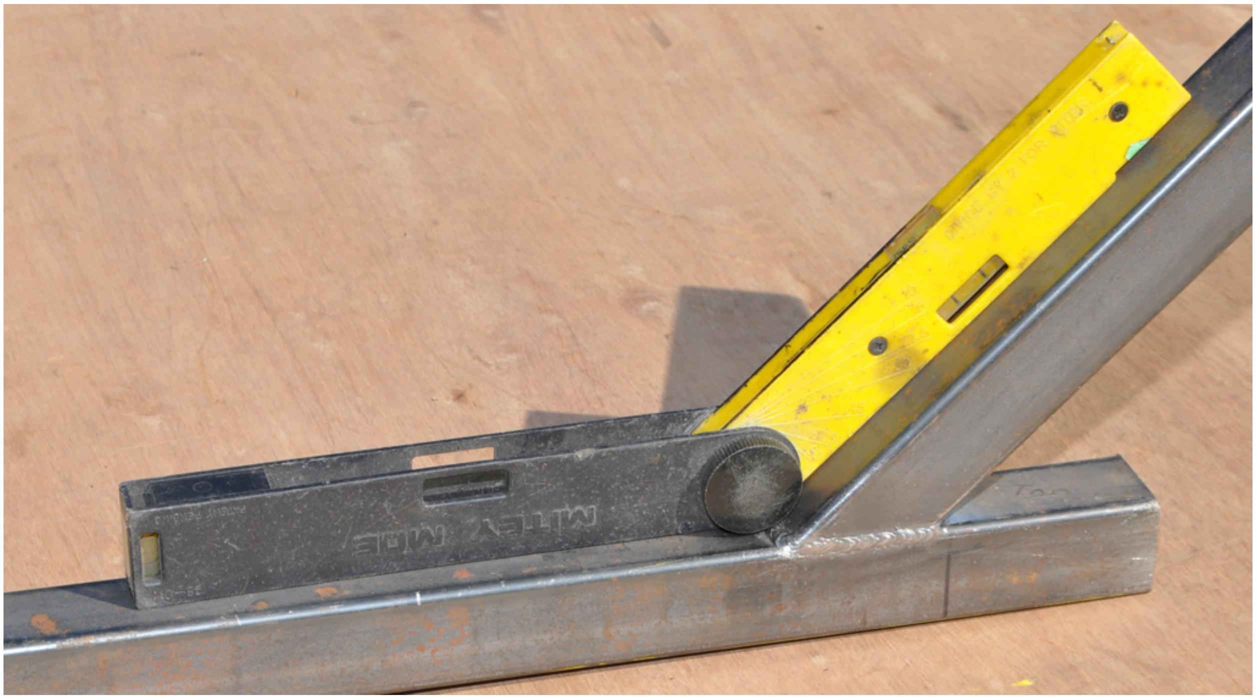


Figure 62 - Checking your angles is easy with an adjustable angle finder

When you are setting up angled joints for welding, an adjustable square (angle finder) is a great tool to have around. Check angles after clamping your work and after the first top weld has been made. There will still be a chance to adjust if necessary. None of the angles in this frame need to be absolutely precise, but try to stay as close to the goal as you can, which in Figure 62, would be 135 degrees (45 degrees + 90 degrees).

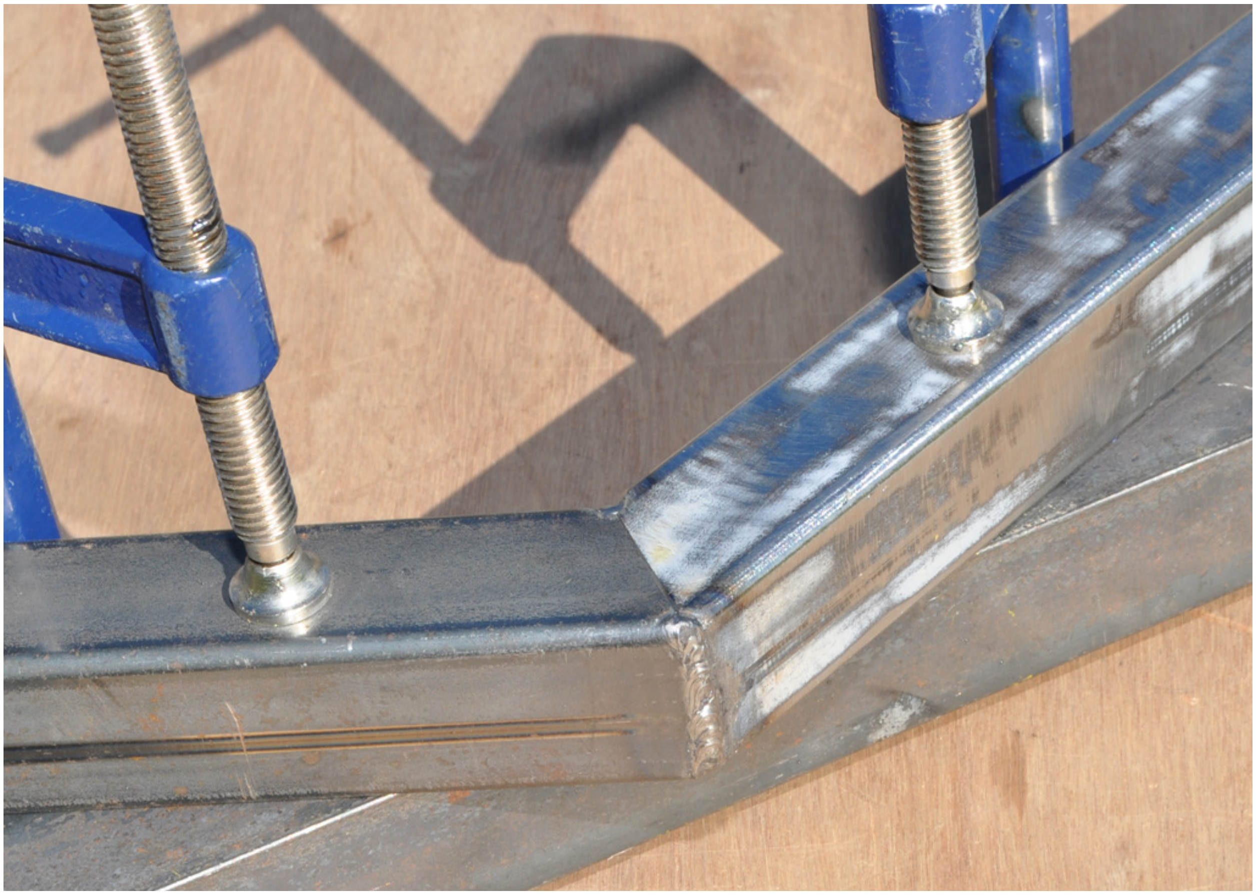


Figure 63 - Using the clamps to install the front boom tube

The front boom tube (C) will now be installed to the front end of the main boom tube (B) as shown in Figure 63 and Drawing 3. Because both of these tubes are cut at 22.5 degrees from the end, the resulting angle will again be 45 degrees from the 90 degree (22.5 + 22.5) or 135 degrees in total, the same as the seat back tube angle.

Use the guide tube and clamps once again and repeat the same process to weld this joint as was done on the seat back tube. Figure 63 shows the top and bottom side of the joint welded first as the clamps hold the work perfectly inline.

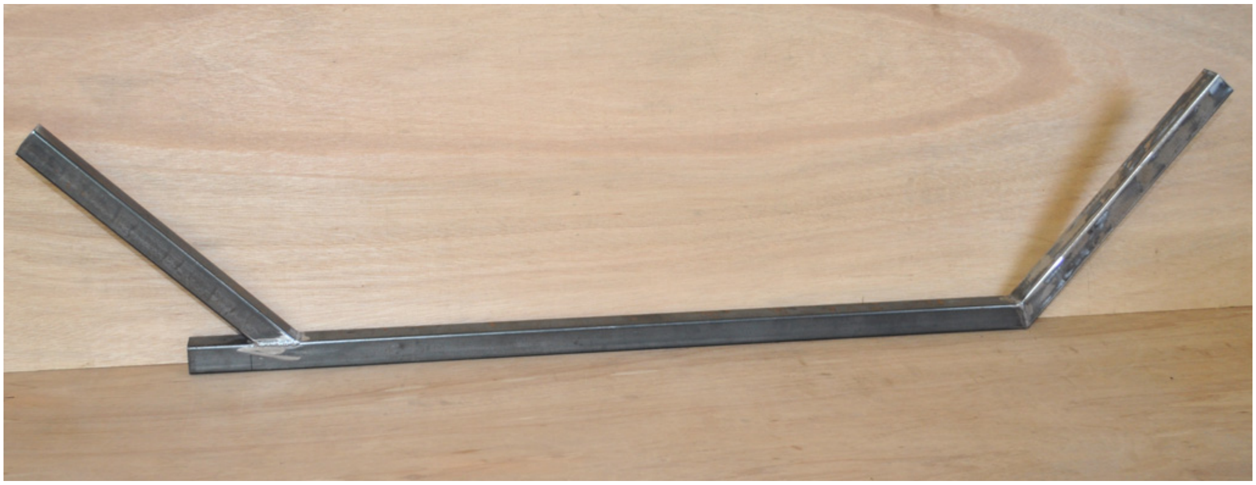


Figure 64 - The main section of the frame is now completed

SUSPENSION PIVOT SYSTEM

Figure 64 shows the main frame section after welding the main boom tube (B), seat back tube (A) and front boom tube (C) together. This assembly will now look just like what is shown in Drawing 3. You can clean up the sides of the joint if you like, but avoid grinding the tops and bottoms of the joints too much as these are the welds that will carry all of the stress.

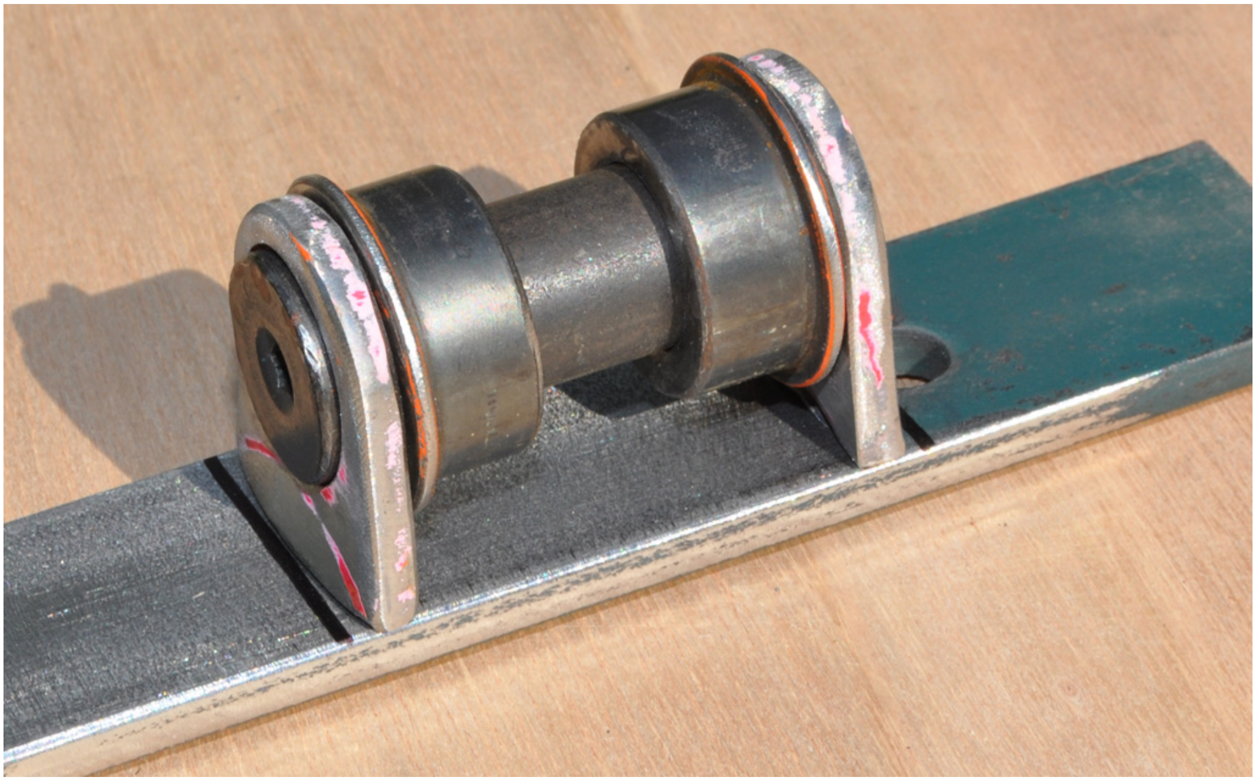


Figure 65 - Cutting a plate to join the suspension tabs

Now, let's complete the swing arm pivot system. The two small arms that you cut from the rear triangle need to be fastened together in order to affix them to the end of the boom of the Aurora Trike frame, so a small length of flatbar with a thickness similar to that of the two arms needs to be cut. Of course, your parts may differ, but in the end the goals are the same, which is a pivot in the frame as shown ahead in Figure 70. The piece of flatbar that I ended up using was 3/16 thick and cut as wide as needed by laying the part over it as shown in Figure 65.

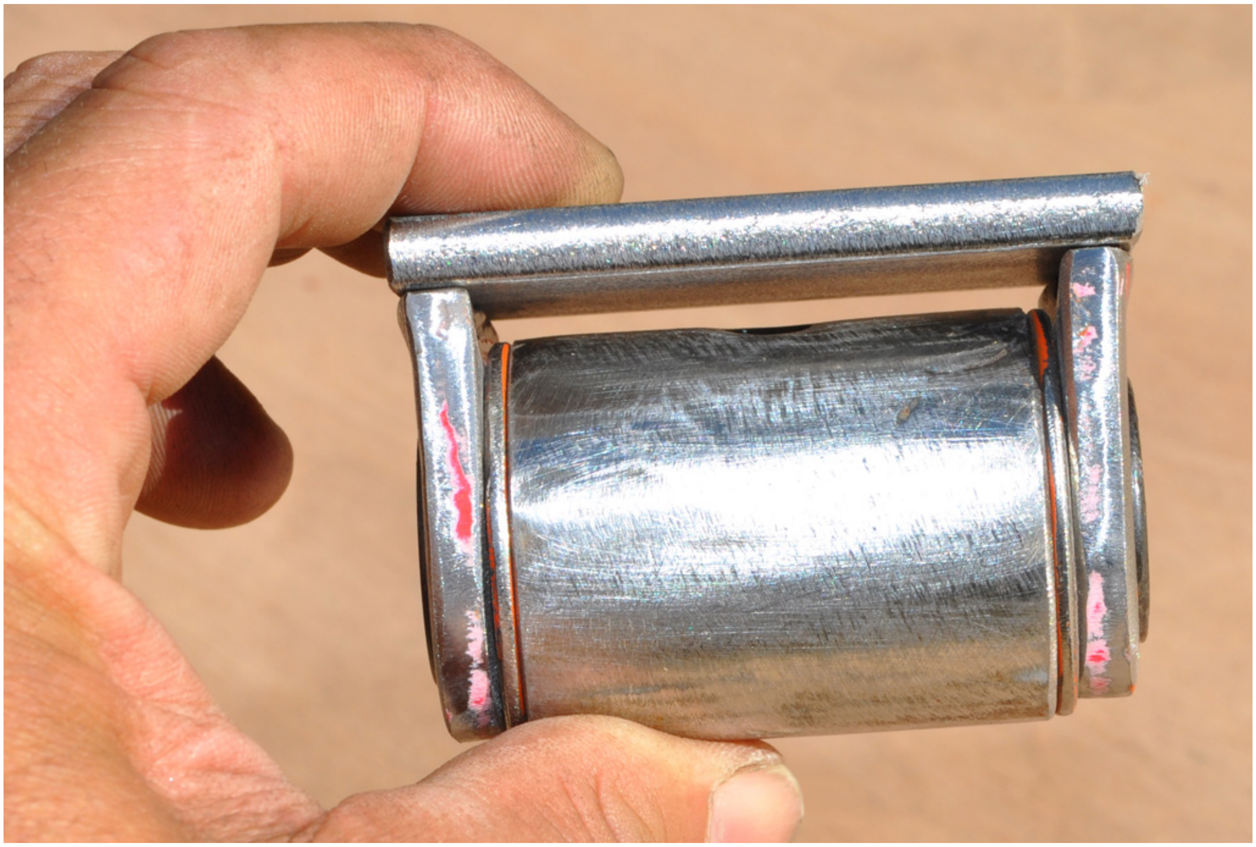


Figure 66 - There should be a small gap to allow the tube to rotate

When you are creating the other half of the suspension pivot hardware, ensure that the pivot tube has a small space as shown in Figure 66 so that it can move freely and not rub against any of the new parts being made. Think of this assembly as a large door hinge; it will function much the same way.

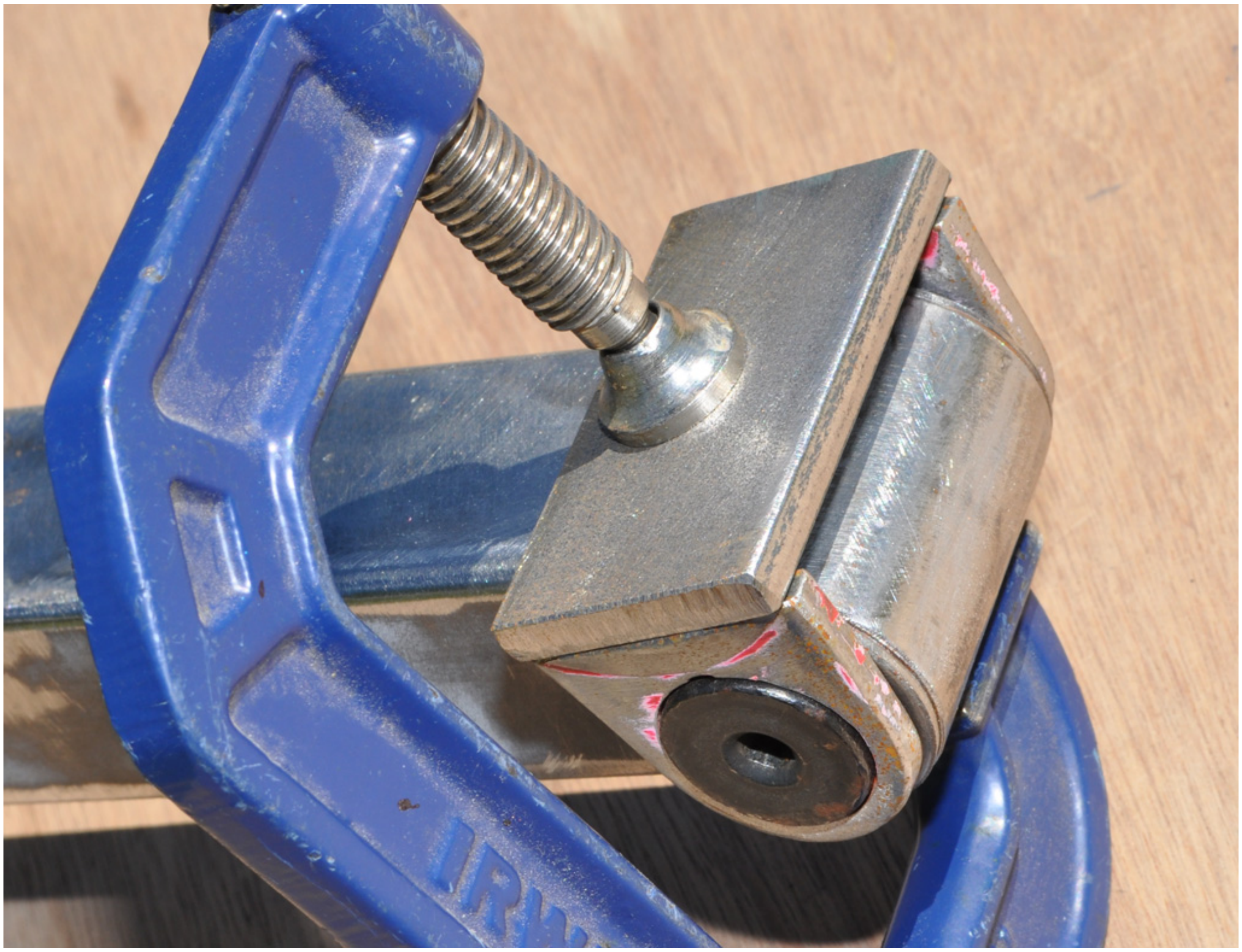


Figure 67 - Setting up the new part for welding

The suspension pivot hardware must allow the two parts of the frame boom to move up and down, but they also must keep both parts perfectly in line so your frame is not skewed to one side. If your hardware is similar to mine and you have made a plate like the one shown in Figure 66, then the clamping method shown in Figure 67 will help keep the parts in good alignment as you weld them together. The frame tubing is being used as a guide here. Remember that you cannot heat plastic bearings, so do not try this if your bearings are not made of metal.

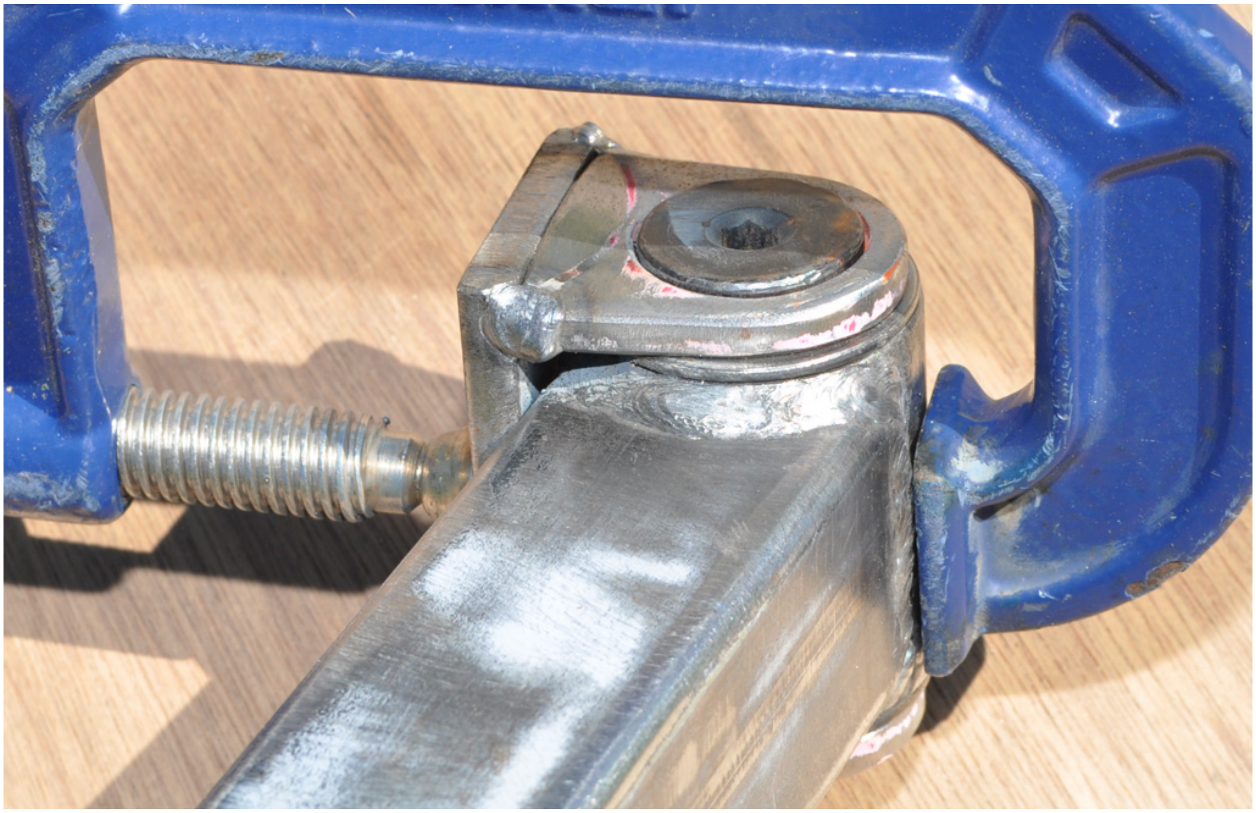


Figure 68 - Tack weld the new plate on all four corners

With the clamp holding the new plate securely and aligned to the frame tubing as shown in Figure 68, apply a solid tack weld at each corner to secure the parts together. Since the new plate is resting directly on the frame tubing, alignment is practically guaranteed.

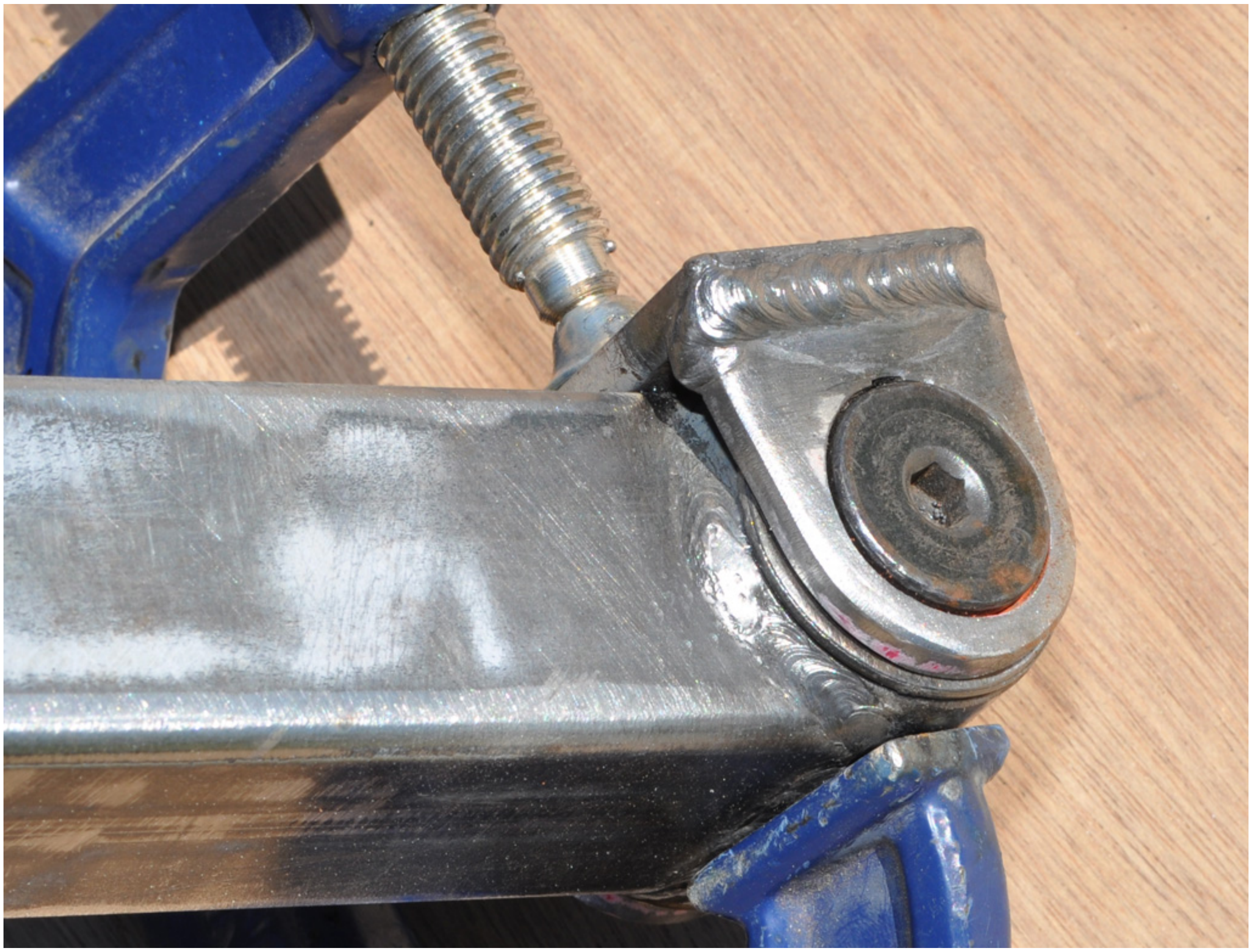


Figure 69 - Complete the welding with the clamp still installed

The welding can be completed along the edge of the joint as shown in Figure 69, keeping the clamp installed to hold the parts in place. Only the outer edge of the joint needs to be welded as there may not be enough space between the inside of the joint and the pivot tube to weld the inside. This completes the rear section of the frame and the suspension link so the rest of the frame can now be made.

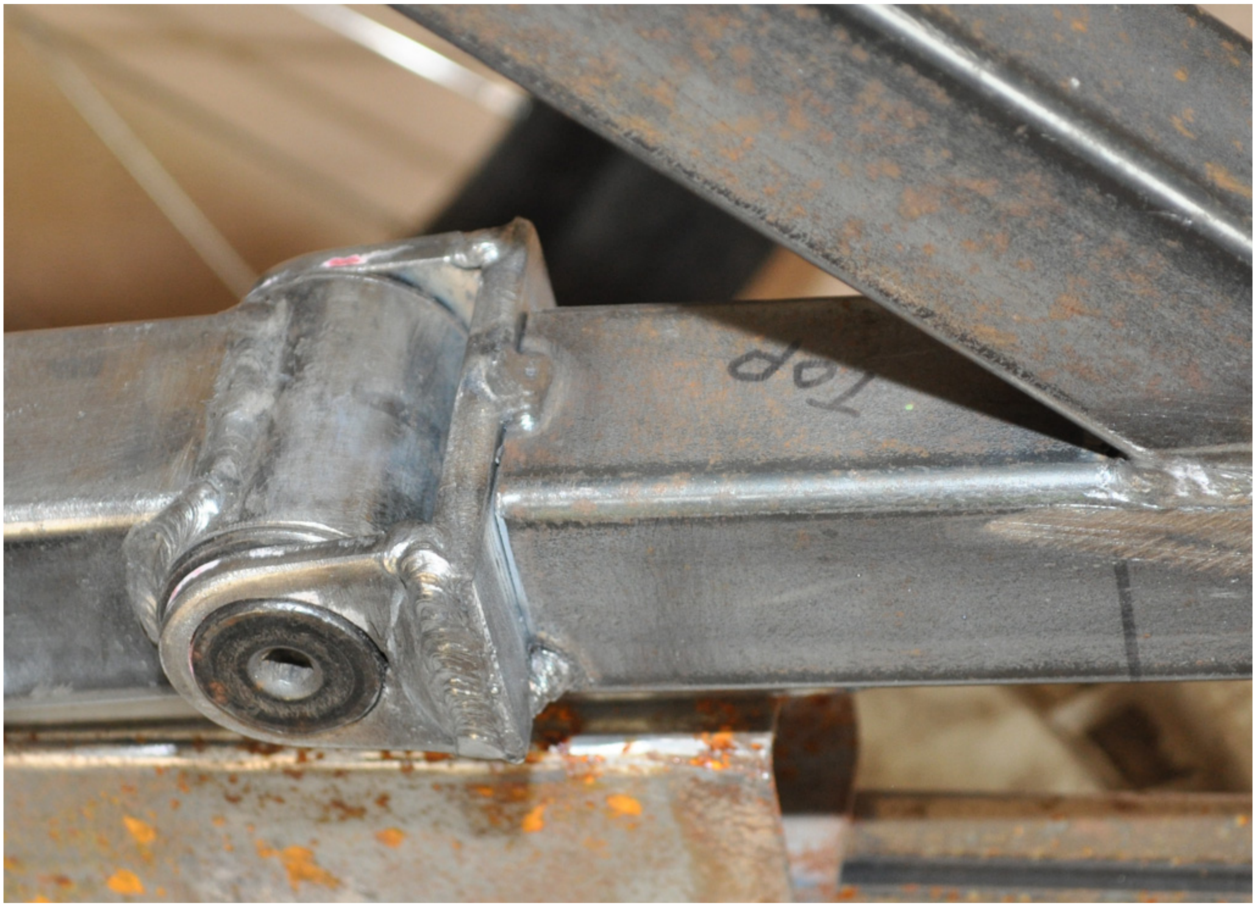


Figure 70 - Tack welding the suspension hardware to the main boom

Install your rear wheels and then prop up the frame pieces together so you can make the tack welds shown in Figure 70, between the rear swing arm and the main boom. Remember to check the 90 degree alignment of the front boom (compared to the ground) while you add the tack welds, as this will be difficult to correct later. Inspect the frame from the front and from the top to ensure that it is aligned so that you can lock it in place with the tack welding. Start with a tack weld at the top of the joint, check alignment, and then add one at each lower corner as shown in Figure 70. Double check your boom and rear alignment, making any corrections that are necessary.

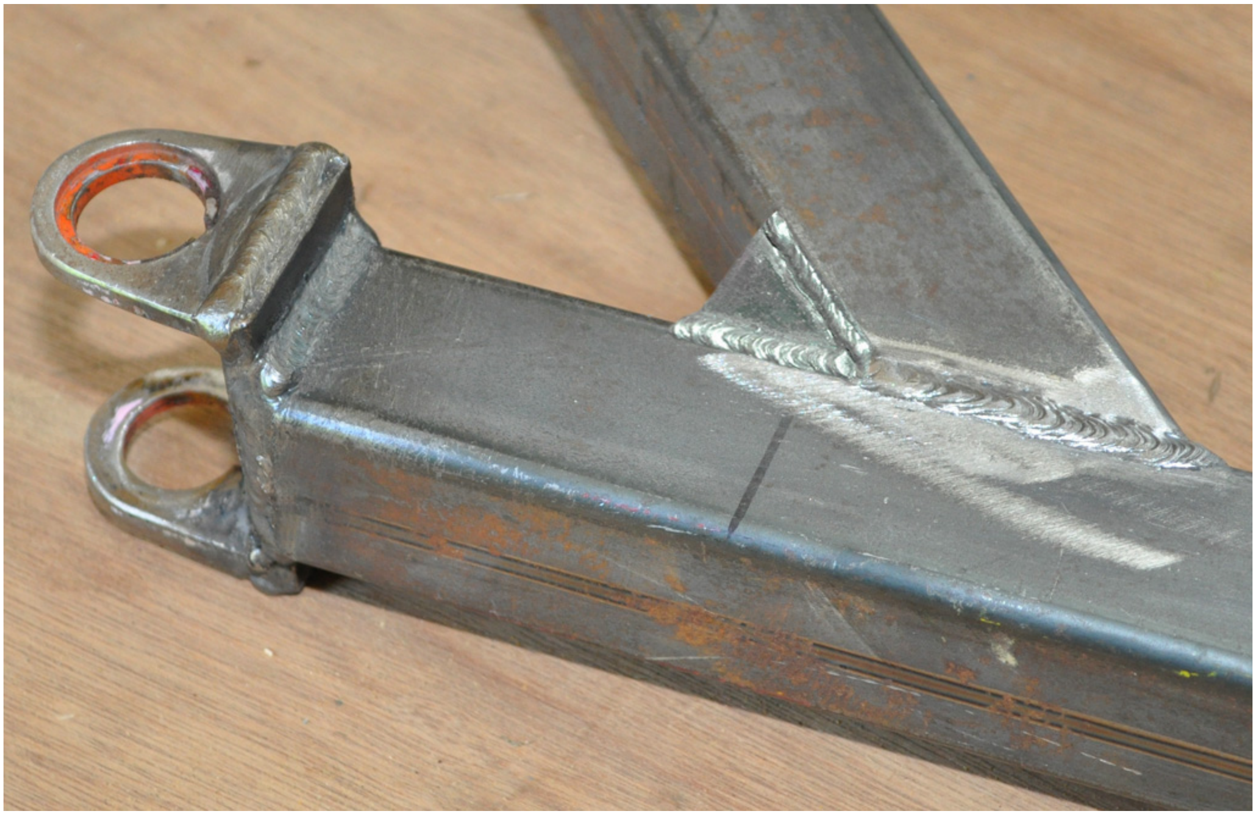


Figure 71 - Completing the suspension pivot joint welding

With the three tack welds holding the suspension part to the end of the main boom, you can carefully remove the pin from the pivot tube bearings and complete the welding around the rear of the main boom tube as shown in Figure 71. Again, weld the top and bottom side of the joint first and then complete the sides to avoid distortion. Also shown here is a pair of small gussets at the corner of the boom and seat tube, which will greatly strengthen the frame. If you are over 180 pounds, or intend to carry cargo, then don't leave out the gussets. The gussets can be made with some scrap tubing or 1/8 thick flat bar. They are about an inch long.

Builders Tip

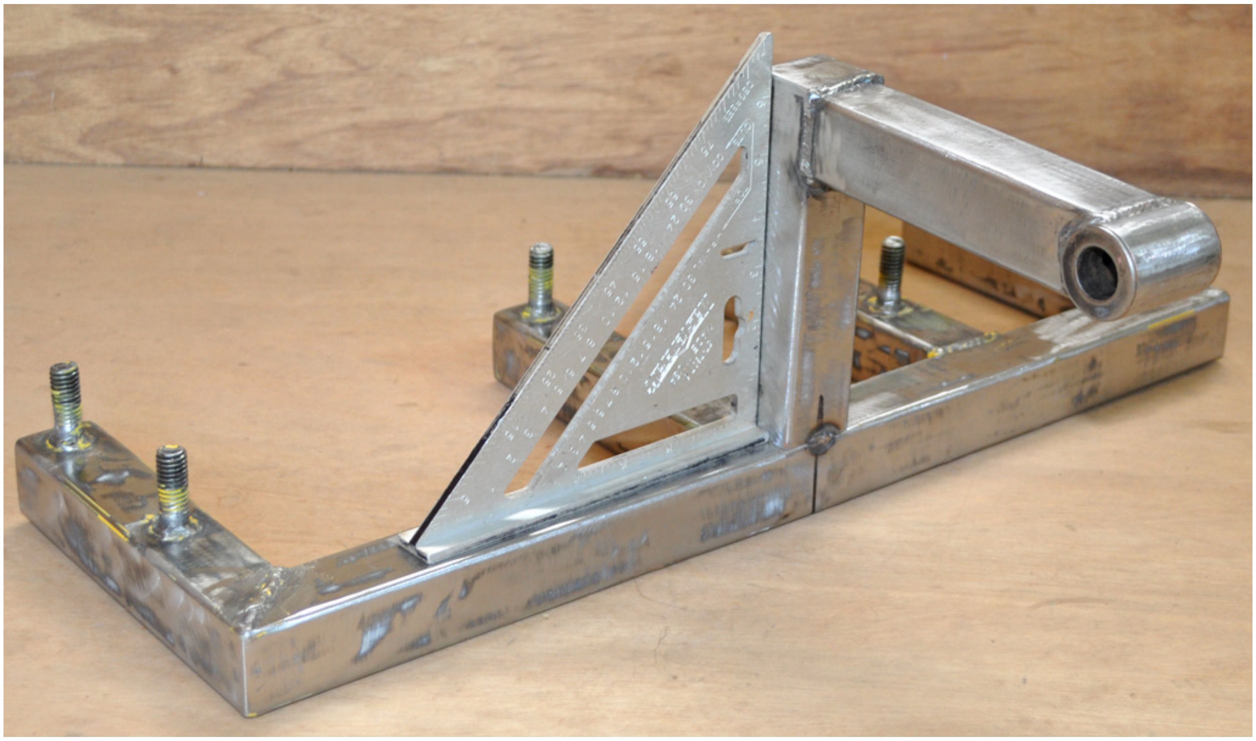


Figure 72 - Join the swing arm to the rear frame

The swing arm assembly can now be joined to the center of the rear frame assembly on the T tube. The reason that this step is done now is so you can install the front frame section as use it as a visual alignment guide in order to ensure that the rear frame assembly is at 90 degrees to the rest of the frame. First use a 90 degree square to align the parts as shown in Figure 72, making a good tack weld at the front and rear of the joint.

Now, install the pivot hardware and then the front section of the frame so you can look at the alignment as viewed from the front and rear length of the frame. The main frame tubing and rear frame assembly should make a 90 degree angle. This is how your three wheels will be aligned so they are all standing at 90 degrees to the ground.

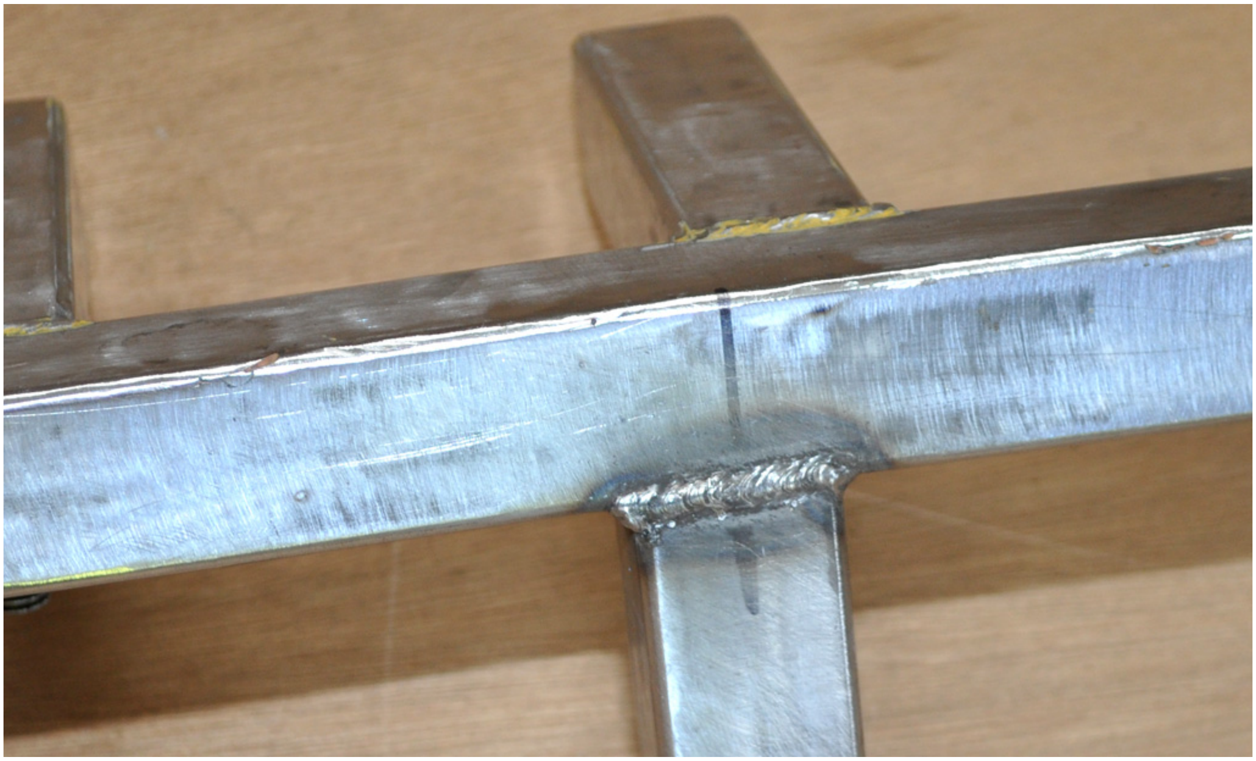


Figure 73 - Weld the front and back of the joint first

Once you have visually inspected the alignment between your rear frame section and front frame section, complete the welding, starting with the front and rear side of the joint as shown in Figure 73. It may be a good idea to add another tack weld in each corner and then check your alignment once more before welding the joint, just to be sure that nothing will move as you complete the welding.

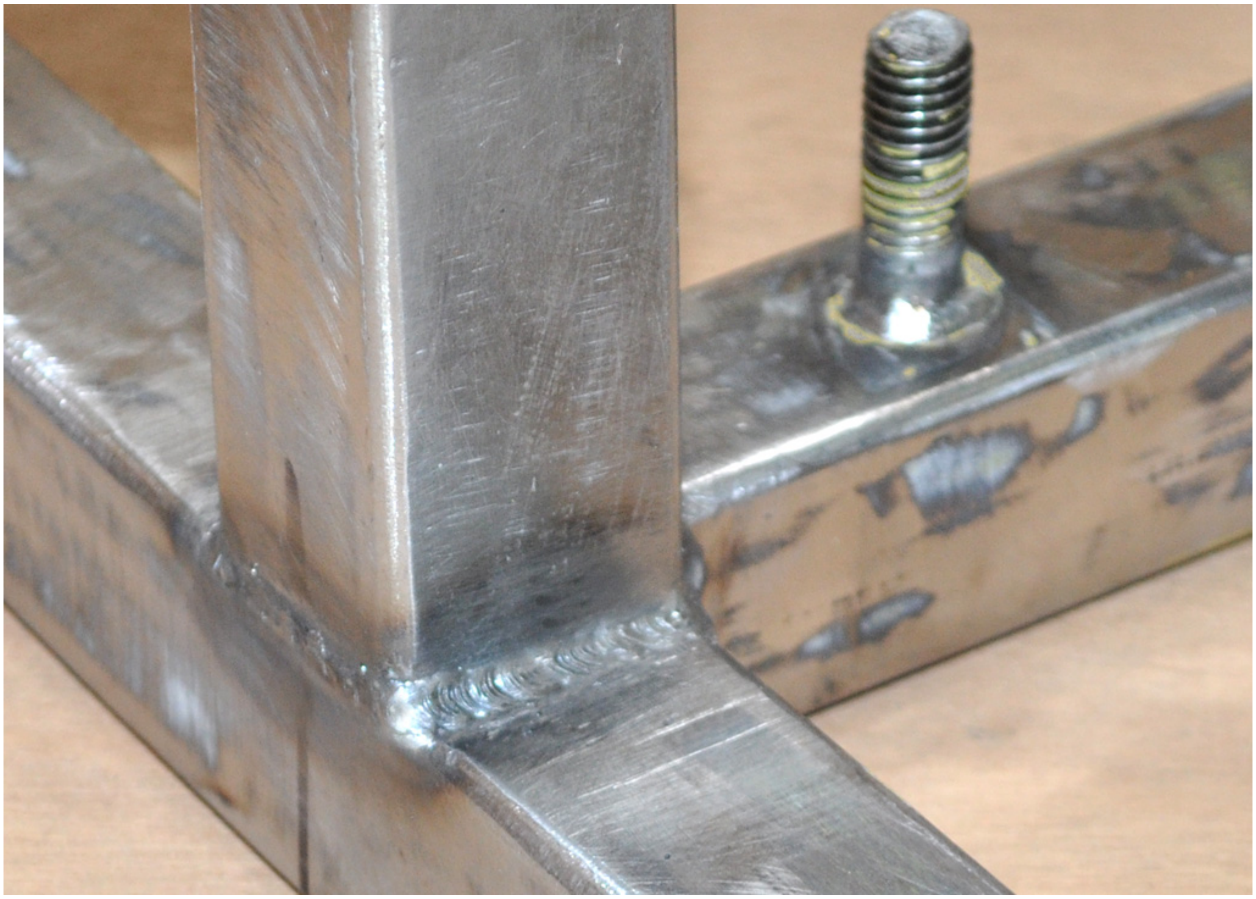


Figure 74 - The swing arm tube joint completely welded

Once the front and rear side of the joint have been welded, complete the sides of the joint as shown in Figure 74. This completes the main frame welding, so it won't be long before you can drive your new trike out of the garage for a test ride.

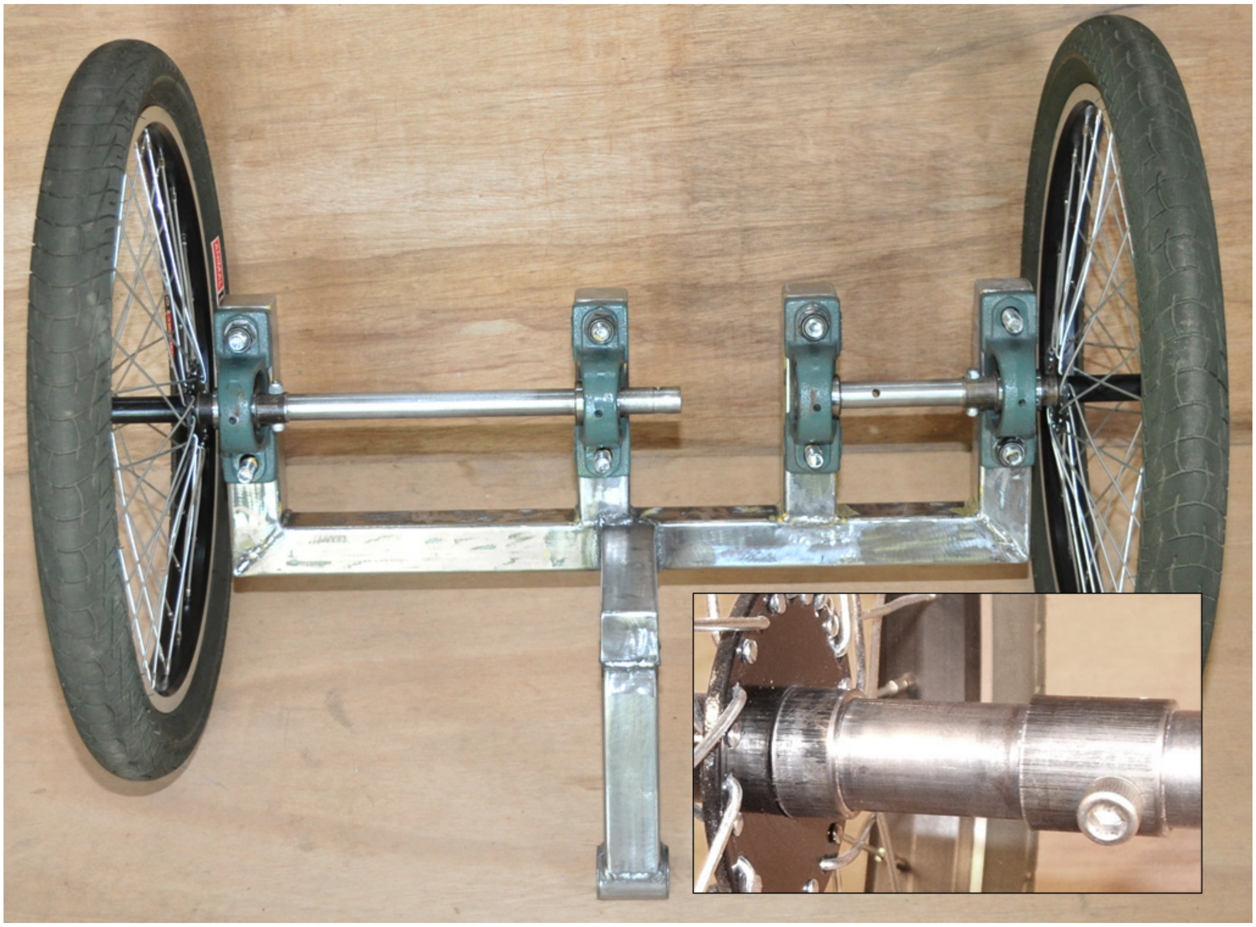


Figure 75

If you haven't done so already, you will need to trim the rear axles to the correct length. Once your pillow block bearing are installed, remove the alignment axle and test fit the two rear wheel axles. They will likely be too long and will need some trimming. Start with the right axle (the shorter one) and insert it into the pillow block bearings until the hub flange is about half an inch away from the bearing ring face. You can now mark the axle for trimming by marking a line about half an inch away from the other bearing face at the open end of the axle. This extra inch of axle will allow you to install the axle spacers, which will be shown later on.

Now, install the left side axle (longer axle) into the other two pillow block bearings. The axle should slide in until there is half an inch between the bearing ring face and hub flange just like it was done on the other axle. You will need more axle sticking out past the inside bearing as there needs to be room on the axle for the freehub adapter (shown in Figure 170). Leave approximately 4 inches of axle as measured from the face of the bearing ring. Figure 75 shows the two axles cut to length, including the extra 4 inches of axle extending past the bearing on the left side axle (drive axle).

REAR SUSPENSION SPRING

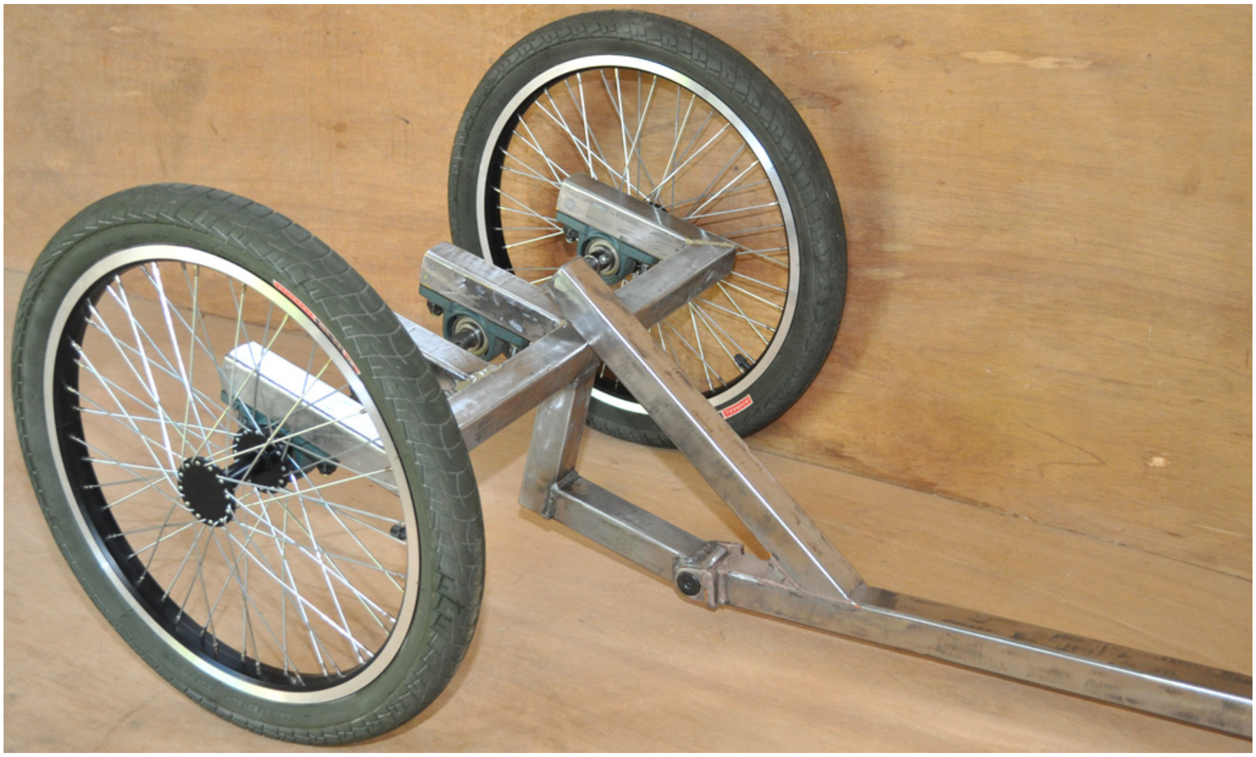


Figure 76 - Setting up the rear of the trike

To install the rear suspension spring, you will need to install the pivot bearing hardware as shown in Figure 76. You don't have to have the rear wheels installed at this time, but I find it is easier to work on the trike and move it around with the rear wheels installed. You only need to install one bolt on each pillow block bearing in order to fasten them to the frame when working on the trike.

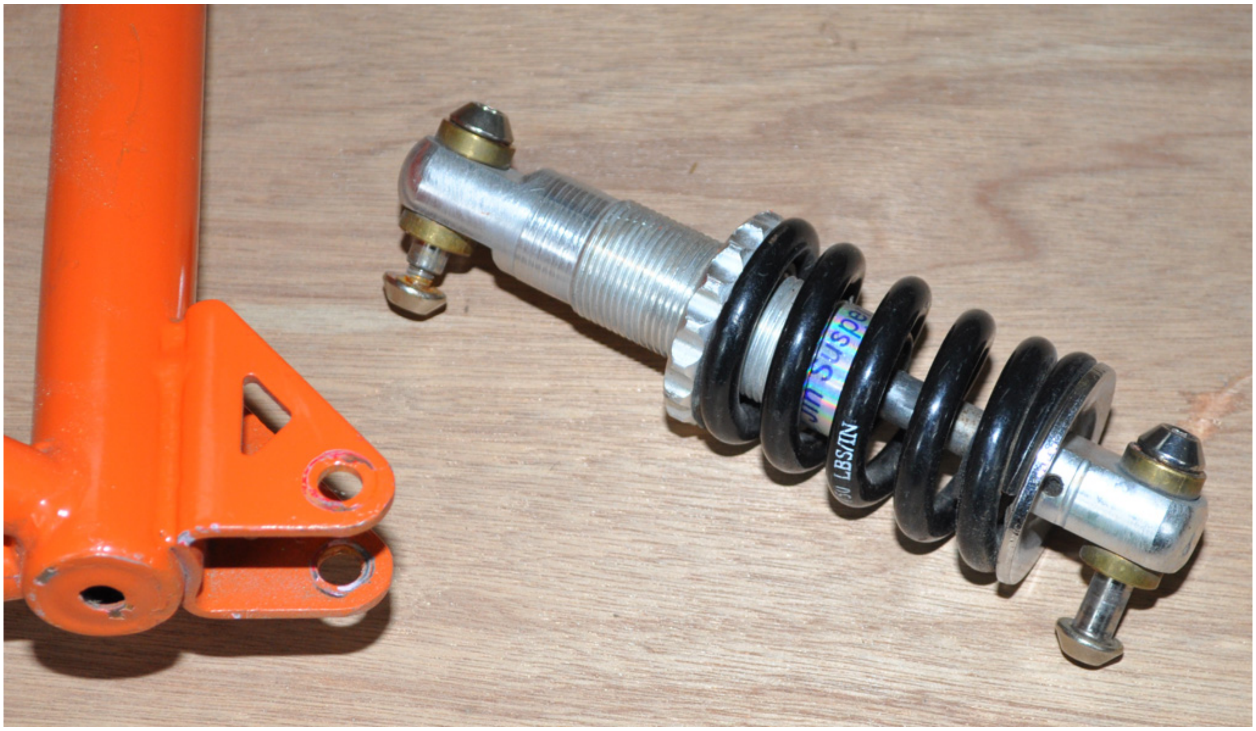


Figure 77 - You will need a set of spring mounting tabs

The suspension spring is held in place by a pair of mounting tabs like the set shown here on the rear triangle in Figure 77. You can either salvage these mounting tabs from an old suspension frame or simply make your own by cutting four triangles from a bit of 1/8 inch thick flatbar.

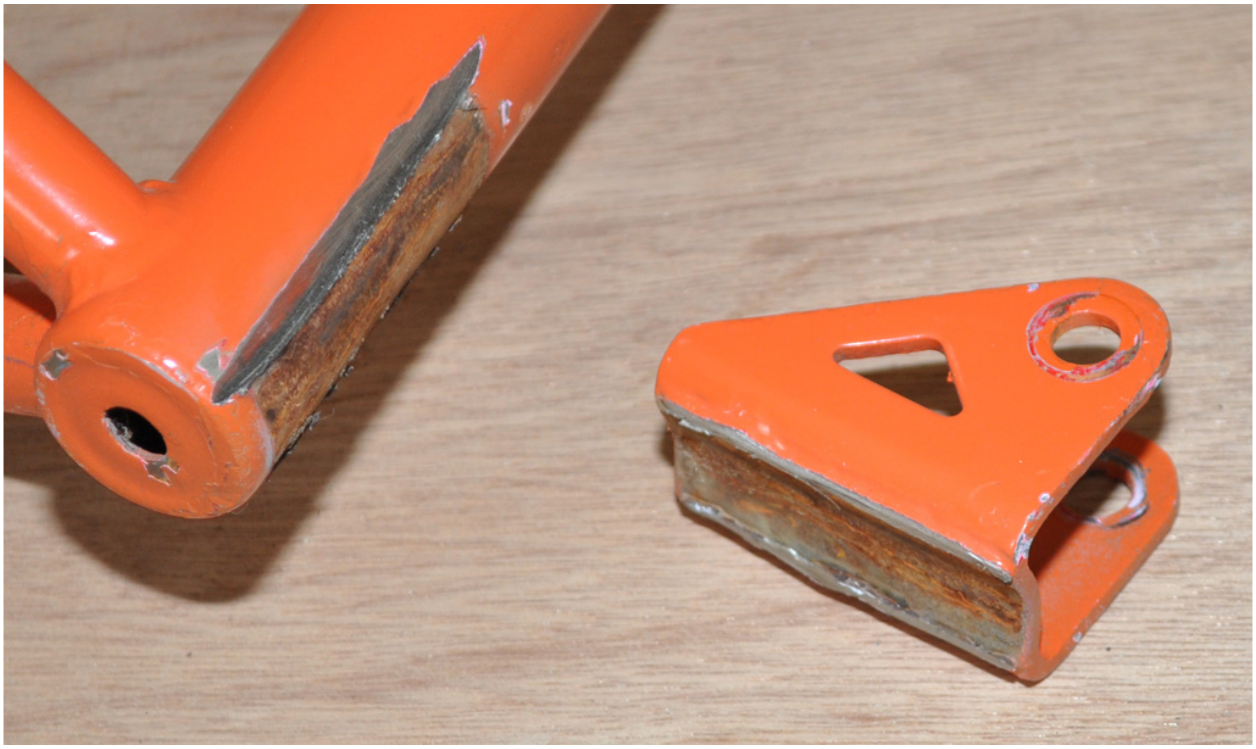


Figure 78 - Cutting the suspension mounting tabs from the frame

The suspension mounting tabs shown in Figure 78 are very easy to salvage from a frame because they will come off in once piece. Some frames have two separate tabs welded to the frame tubing, so you will need to cut them both and then grind them to ensure that they are exactly the same size.

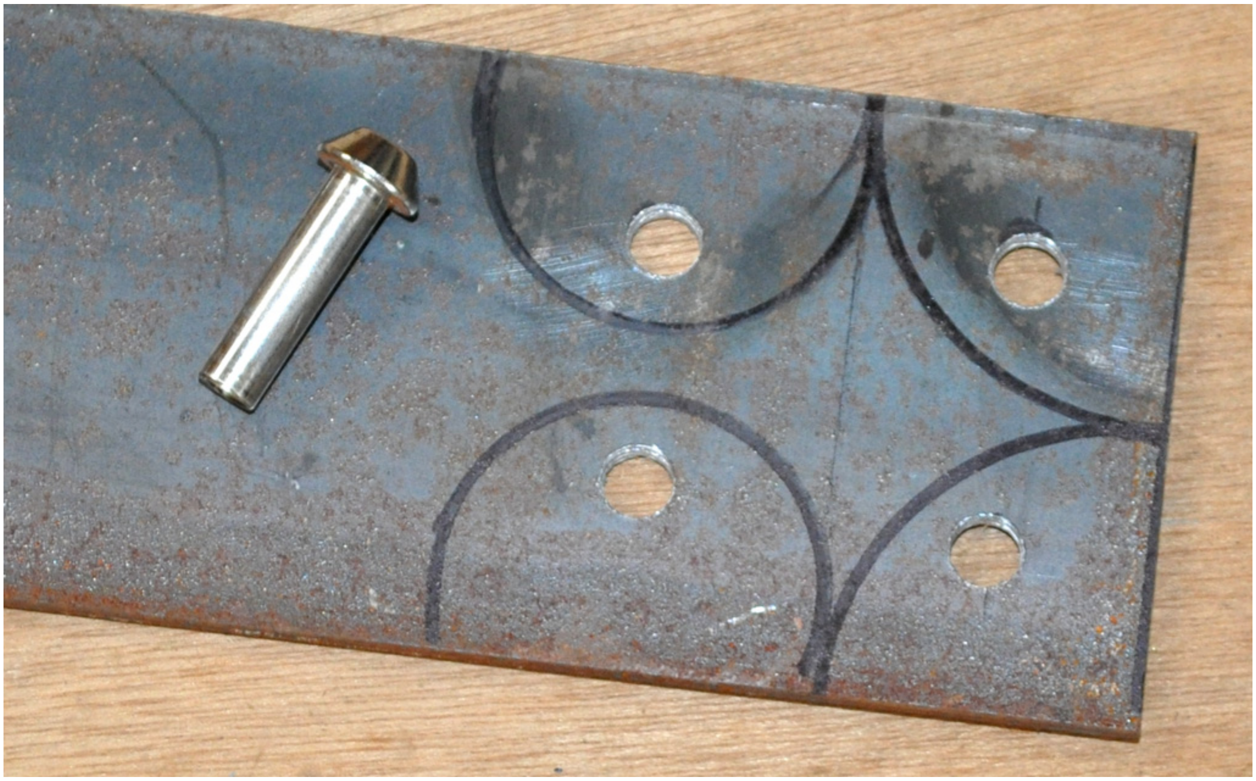


Figure 79 - Creating suspension tabs from flatbar

To make your own suspension spring mounting tabs, draw a set of triangles or half circles onto some 1/8 inch thick or slightly thicker flatbar as shown in Figure 79. A triangle with a base of 1.5 inches and a height of about 1 inch will be perfect. It is also easier to drill the holes before cutting so you have something to hold while you drill. To drill an accurate hole, start with a small bit and work your way up to the required size, which will likely be 5/16 for most suspension spring bolts.

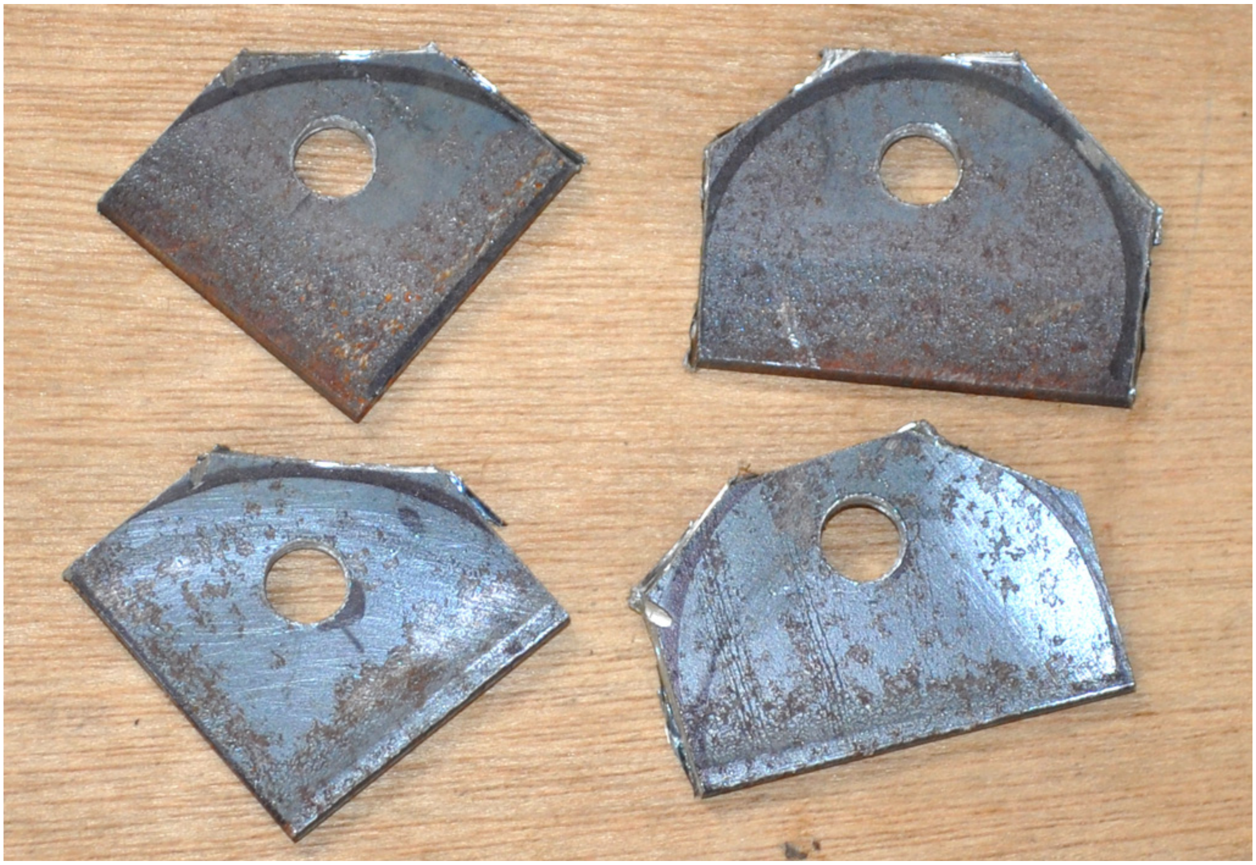


Figure 80 - Rough cut suspension spring mounting tabs

The rough cut suspension spring mounting tabs are shown in Figure 80 after hacking them out of the flatbar with a zip disc. Notice the two tabs on the left have a triangular base. These ones will fit into the corner where the two swing arm tubes make the 90 degree joint.

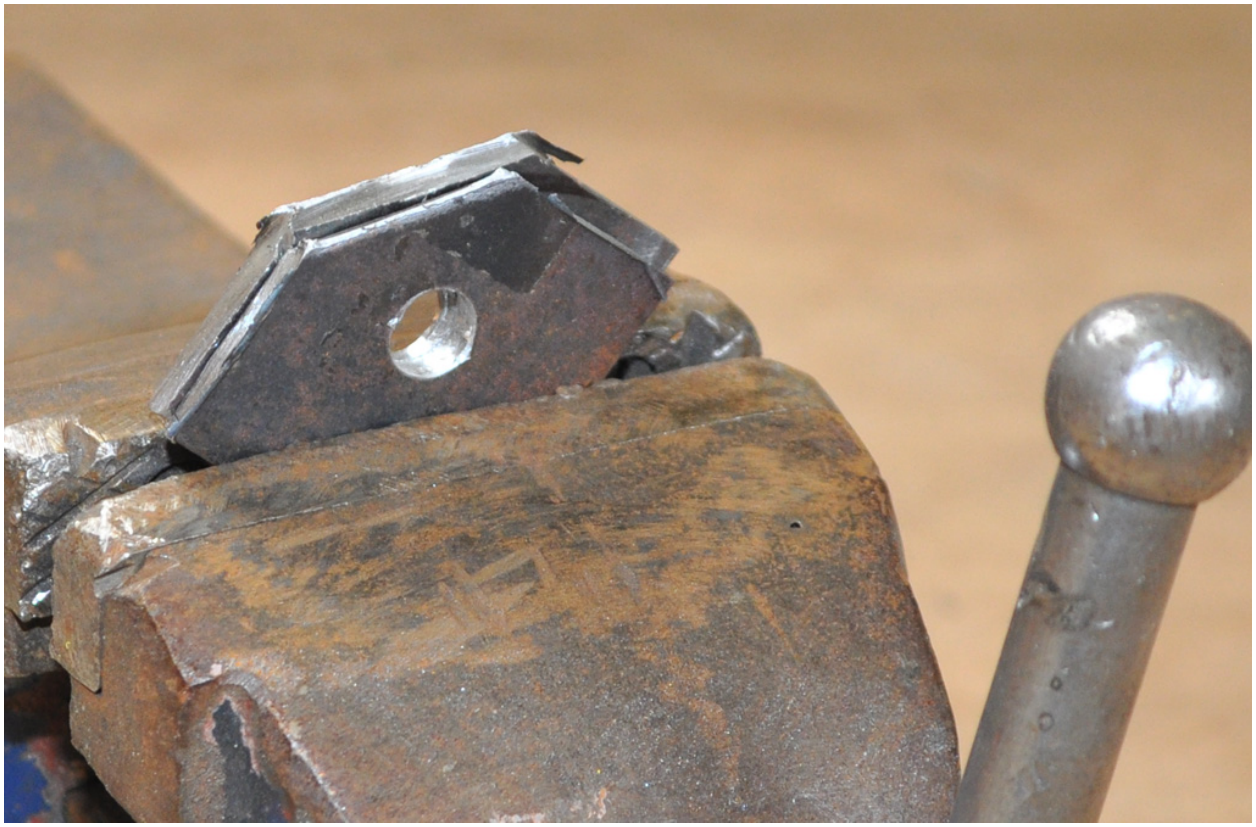


Figure 81 - Cleaning up the handmade mounting tabs

It is important that your suspension spring mounting tabs be of equal size, so align them by the drill hole in a vice and then grind them together to make them exactly the same shape (Figure 81). Take off sharp edges using a sanding disc.

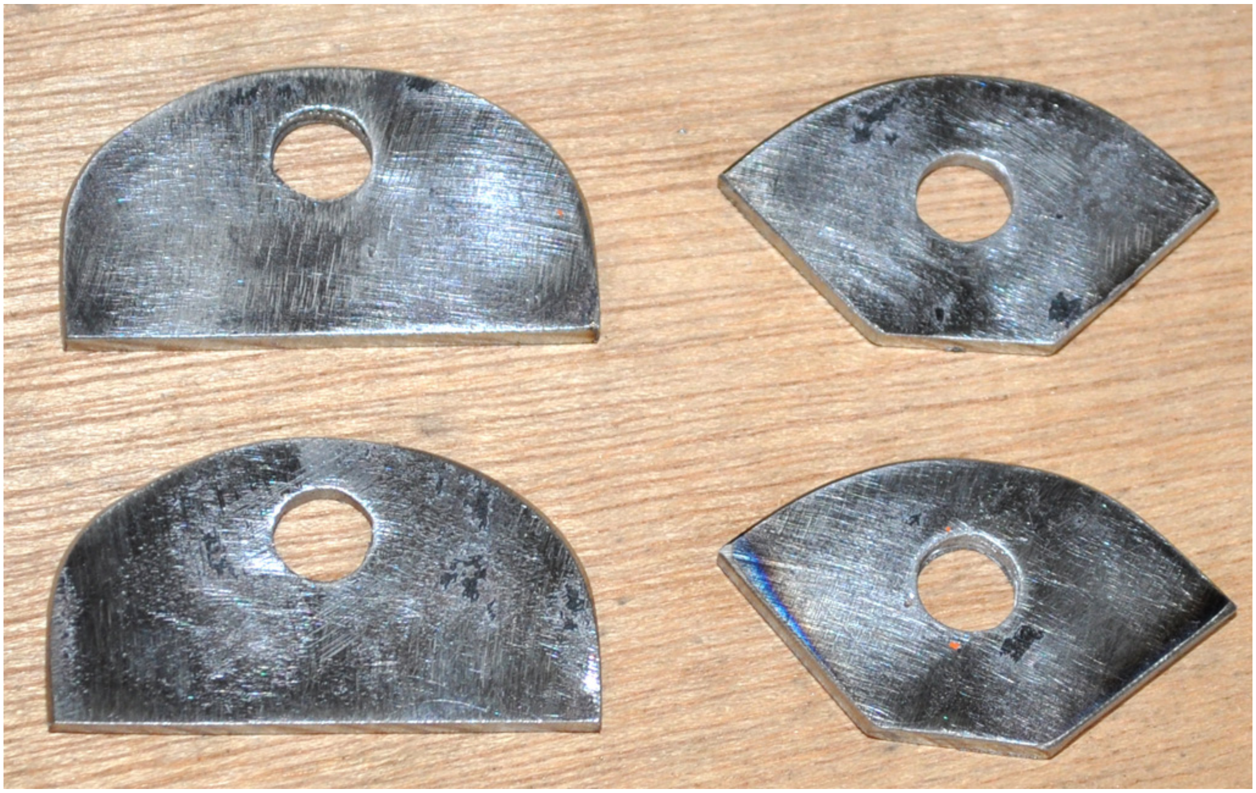


Figure 82 - The four completed suspension mounting tabs

Once the suspension spring mounting tabs are ground into equal sized pairs, clean them up with a sanding disc as shown in Figure 82, removing any sharp edges where the flat bar was cut.

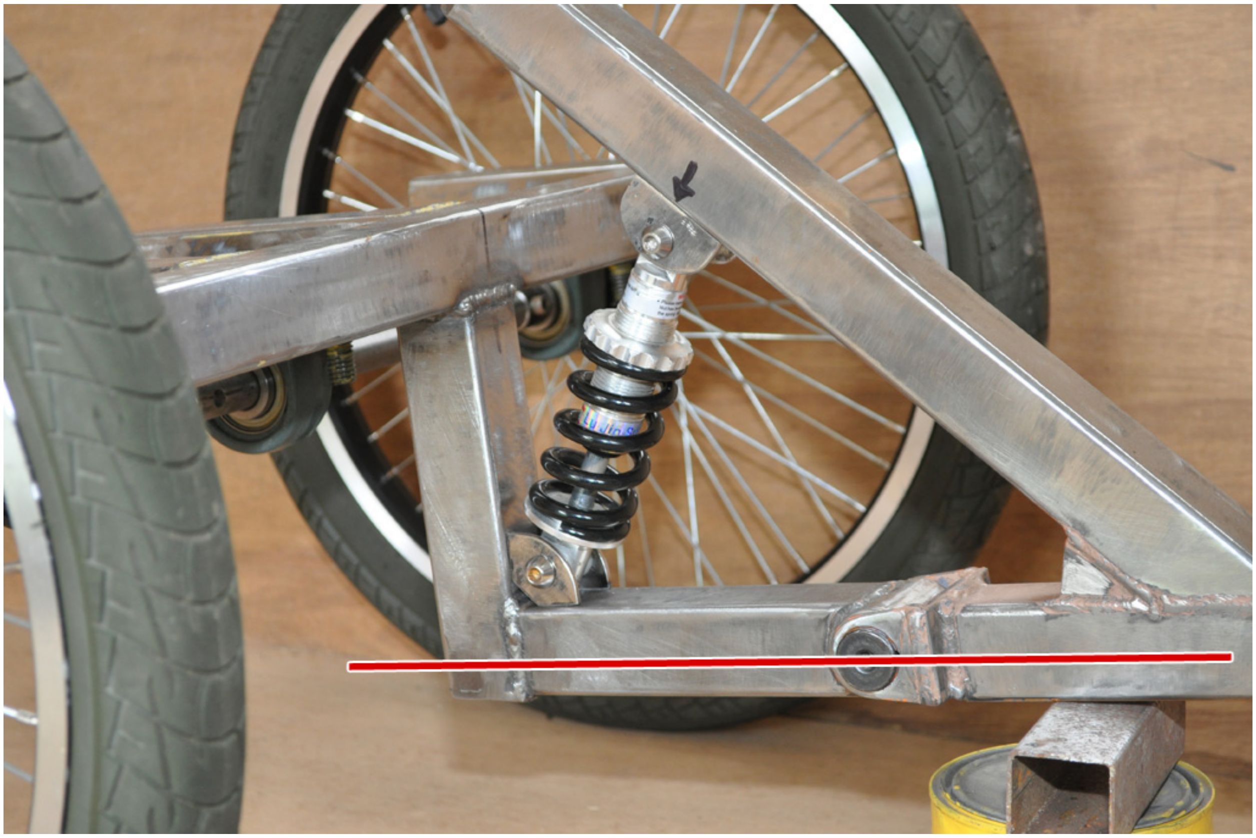


Figure 83 - Placing your suspension spring on the frame

It's easy to find the optimal position to install the suspension spring by placing it on the frame as shown in Figure 83 so that the main frame boom tube forms a line with the horizontal tube on the swing arm assembly (red line). The bottom of the suspension spring will live at the 90 degree corner of the swing arm assembly, and the top of the spring will end up around 10 inches from the front corner of the seat tube. Don't worry about the position of the top suspension mounting tabs too much, just set the boom and swing arm tubes horizontally together as shown by the red line in Figure 83.

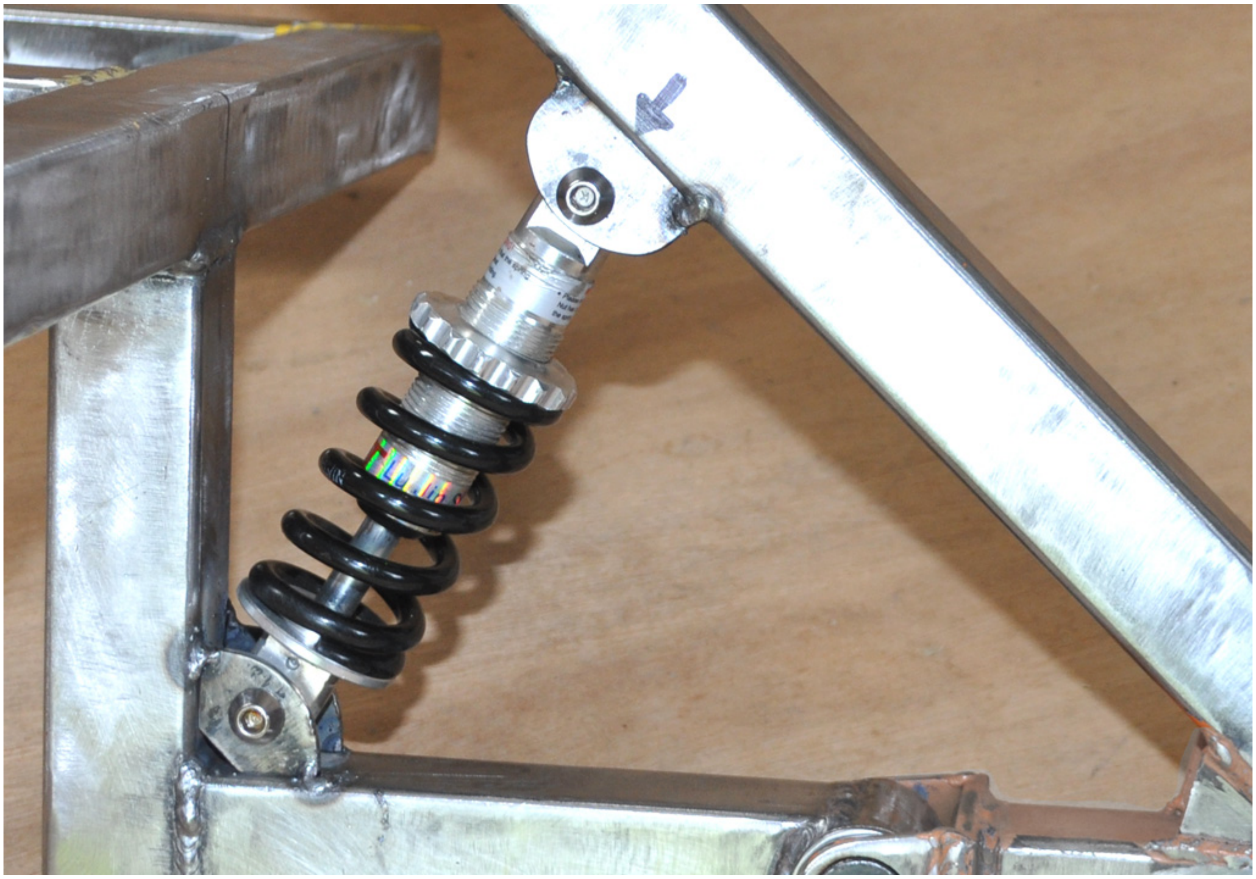


Figure 84 - Tack welding the suspension spring mounting tabs

Once you have marked the position to install the suspension spring mounting tabs on the frame, tack weld them in place at each corner as shown in Figure 84. Since you are going to do this with the spring installed as a guide, cover it up with a damp cloth to protect it from welding spatter, and keep you tack welds to a minimum so you don't melt the plastic bushing around the mounting bolt.

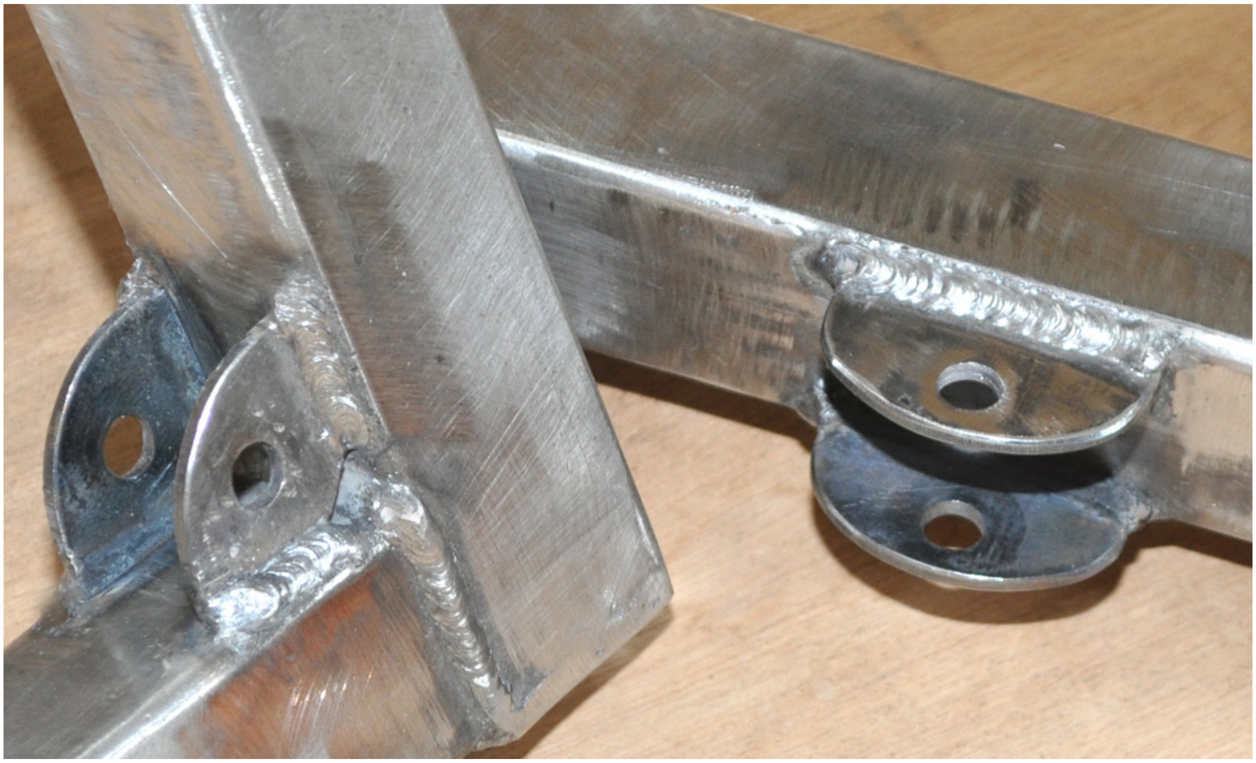


Figure 85 - Welding the suspension spring mounting tabs

Once the suspension spring mounting tabs have been tack welded to the frame tubing in the correct position, remove the suspension spring and complete the welding only on the outside of the joints as shown in Figure 85.

THE FRONT HEAD TUBE

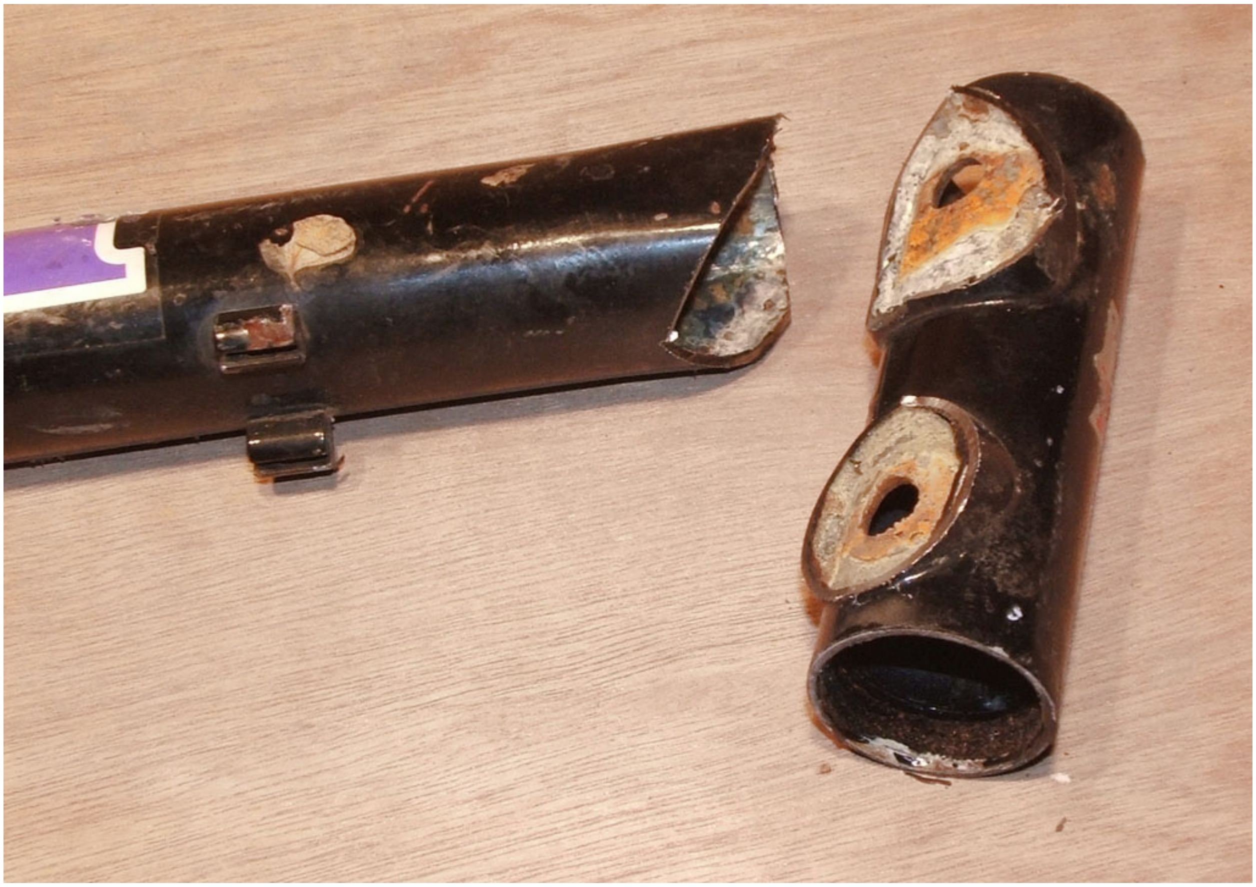


Figure 86 - Cutting a head tube from an old bicycle frame

If you have not already chosen a front wheel and forks, then now is the time. Once again, you will need the tire installed and inflated on the rim. The Aurora Trike can be made with a solid fork or a suspension fork, and requires a 20 inch wheel along with a set of 20 inch forks and matching head tube hardware. If you plan to use a front suspension fork, keep in mind that the upper portion of the crown needs to be steel not aluminum as you will need to weld to it later. Twenty inch suspension forks are not usually decent quality as they are mainly found on kids' bikes, and in reality, the rear suspension will take up most of the road shock due to the length of the main boom. Twenty inch rigid front forks are probably your best choice and certainly the best choice if you intend to add a front hub motor at some time.

You will need a head tube that matches the stem length on your chosen front forks. It does not have to be from the same frame that the forks were taken as long as you can install the hardware and have the forks spin freely. If the threaded fork stem is a bit too long, it can usually be cut to length, and if the fork threads are too short, you can also trim the head tube to fit. Figure 86 shows the head tube I will be using, cut from an old scrap frame that was in my stock pile. Cut the head tube as close to the joint as you can, but avoid nicking the tube.

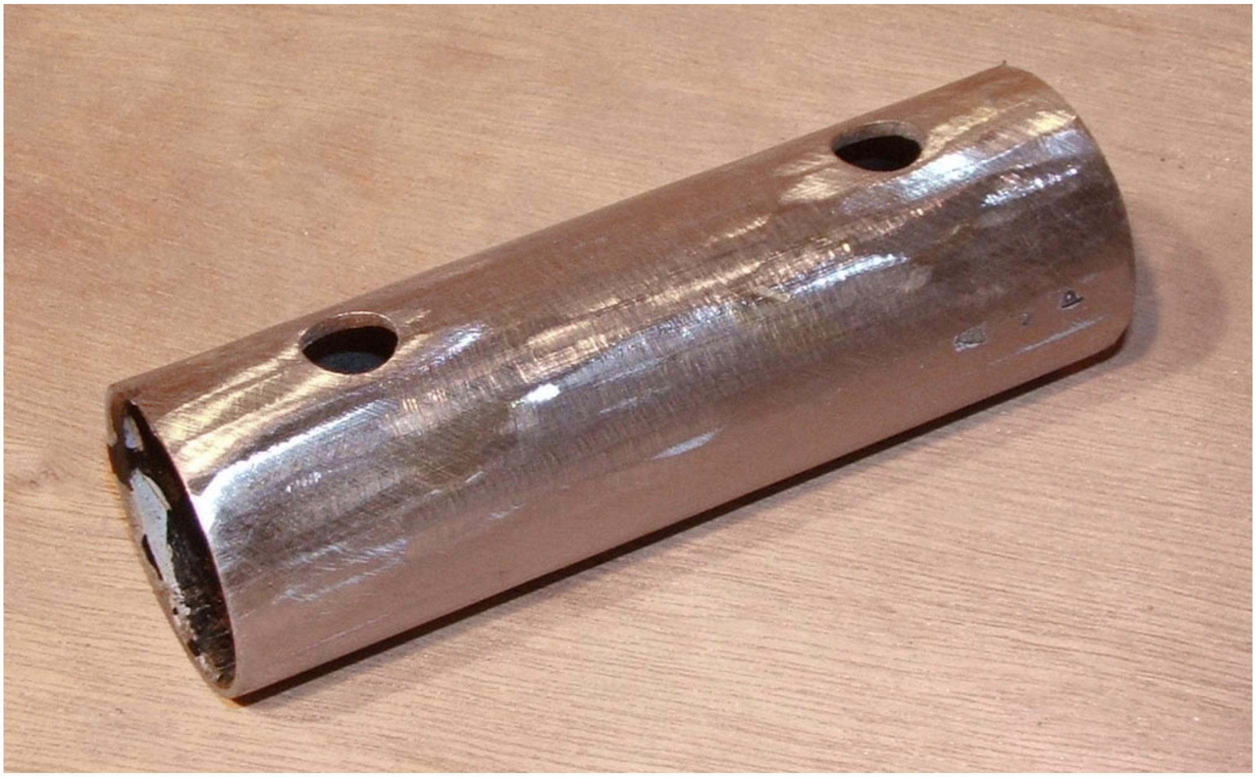


Figure 87 - Grind the head tube clean

The head tube is ground clean as shown in Figure 87 to remove all excess metal from the original frame tubing. A rough grinding disc makes easy work of cutting down the tubing and the flap disc makes the part look like new again.

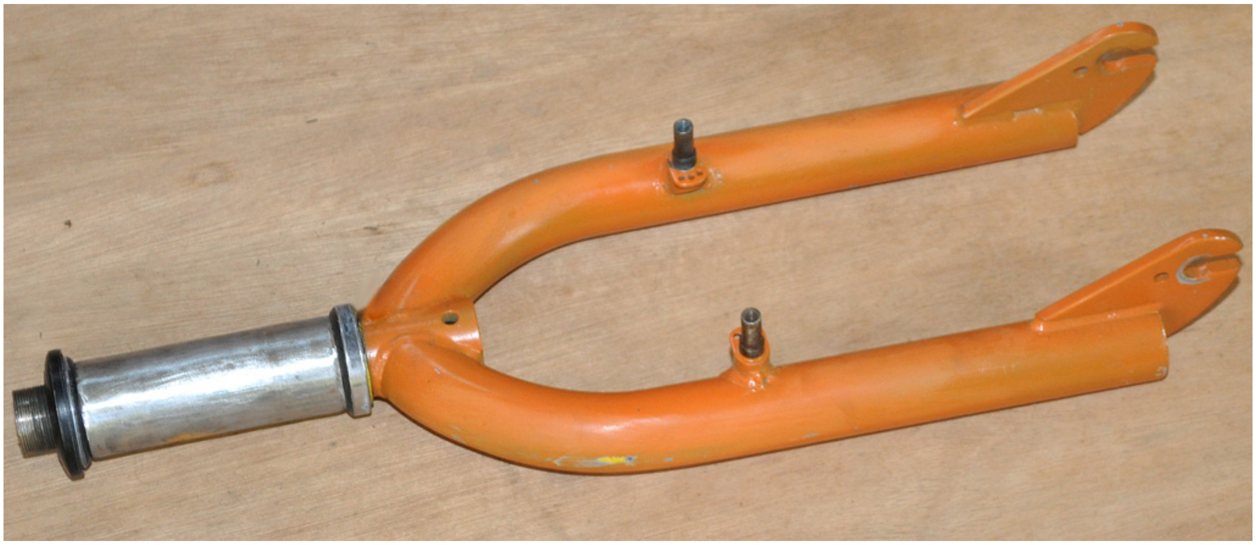


Figure 88 - The front forks and head tube hardware assembled

Builders Tip

There are a few different sizes of head tube cups, so it is important to use a matched set of bearings and rings. If all of the parts came from the same bike, then you are all set. Remember that bearings go into the cups “balls first” and when all of the hardware is tight so there is no play, the forks should spin freely in the head tube. If there is any amount of friction, then either the bearings are in backwards or something is the wrong size. Figure 88 shows the head tube after grinding with the bearing cups, bearings, and top race installed for testing.

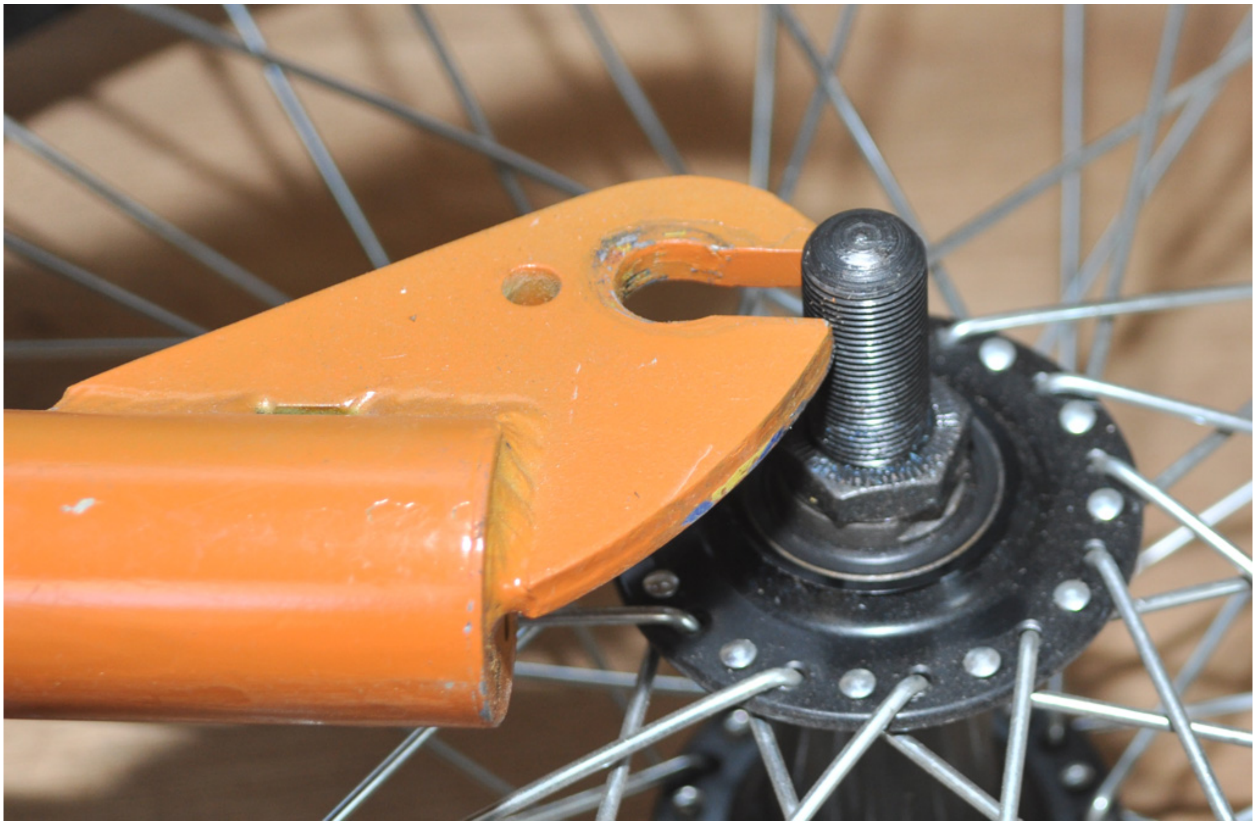


Figure 89 - A 14mm axle is too large for a regular dropout

Since I decided to purchase three matching rims for this trike, I ended up with a front wheel that had 48 spokes and a 14mm diameter axle. This wheels are absolutely indestructible, but the larger axles will not fit into a regular sized dropout like the one shown in Figure 89. No problem - just mark a line and grind them out larger using a zip disc or cut them with a hacksaw. Make a cut slightly smaller than you need and then fine tune the dropout slot with a flat file.

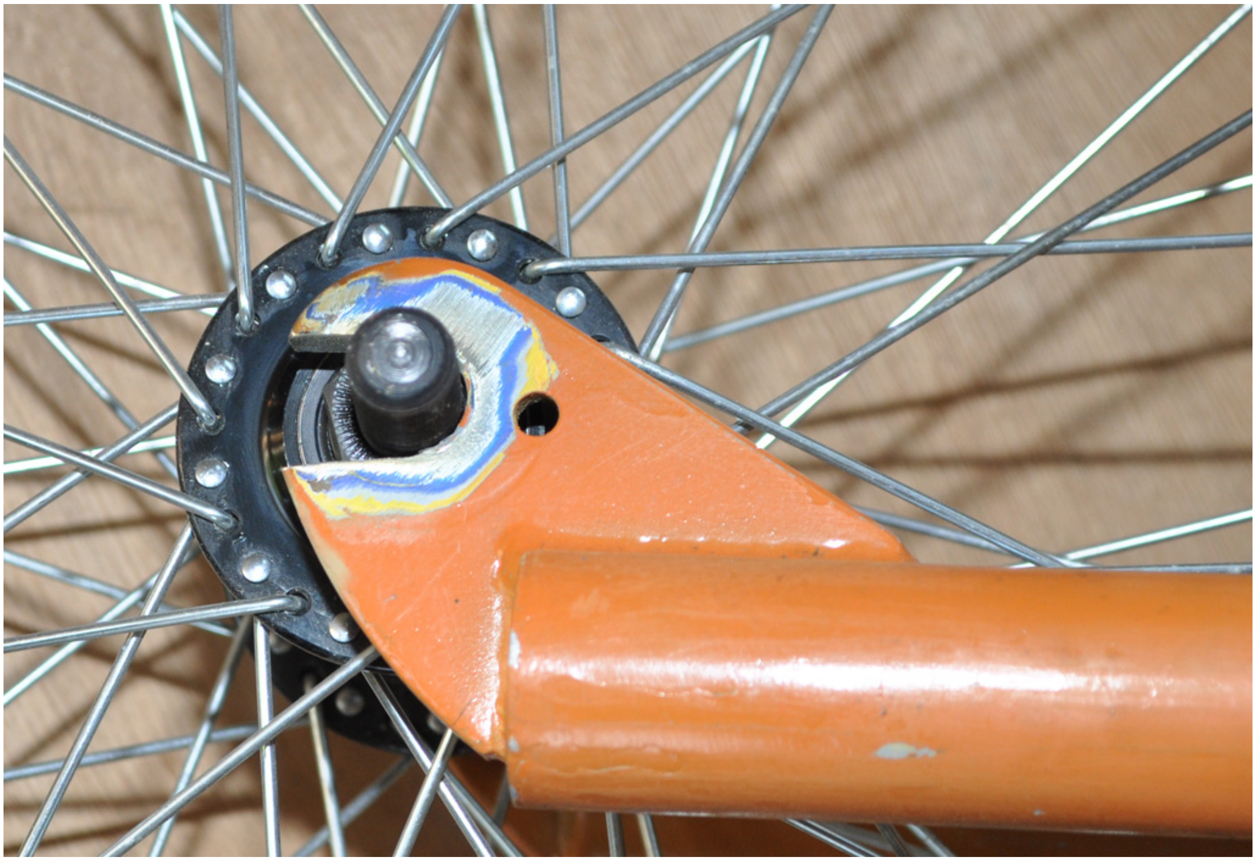


Figure 90 - The modified 14mm fork dropout

The wider front fork dropout is shown in Figure 90 after some modifications with the grinder disc. The 14mm axle now fits perfectly into the slot. As you can see by the 4 different layers of paint - I am a true believer in recycling my bike parts!

HEAD TUBE ANGLE

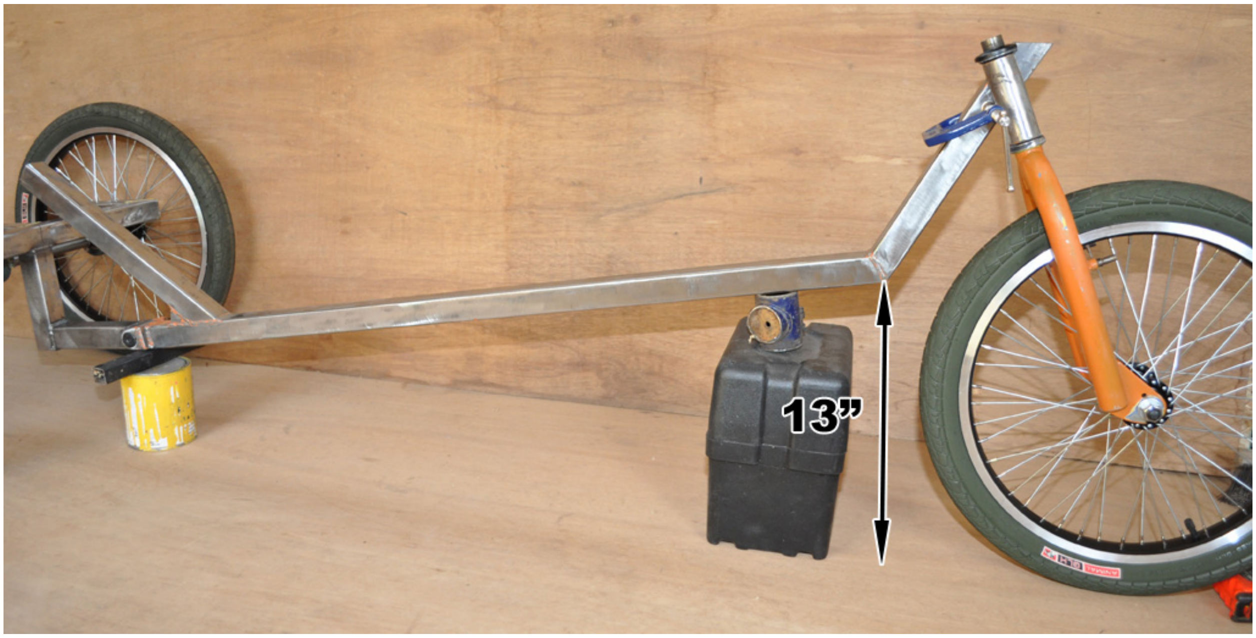


Figure 91 - Setting up the frame to join the head tube

The head tube will now be installed on the Aurora frame. Install your rear wheels (with inflated tires) as well as the suspension system so that the trike is sitting normally at the rear end. Find some object to prop up the front of the frame so there is about 13 inches of clearance between the front boom corner and the ground as shown in Figure 91.

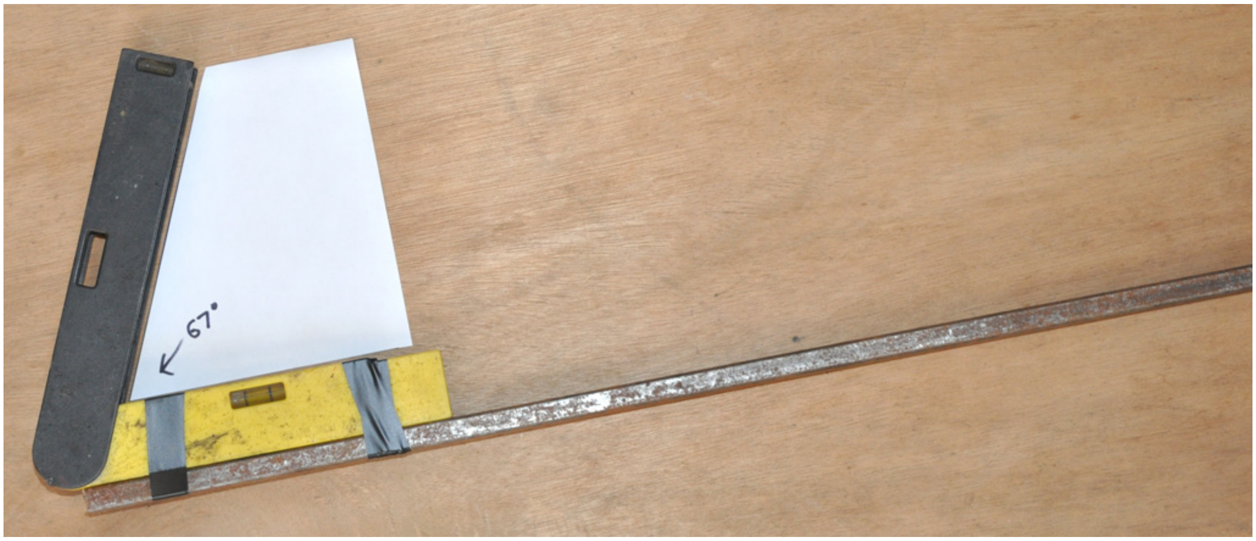


Figure 92 - Making a 67 degree angle guide

The head tube angle on the Aurora Trike will be set to 67 degrees as measure between the head tube and the ground. To help set this angle, an adjustable square with a long straight rod taped to one side is the ultimate tool to make this job easy. Use any computer graphics program or even a protractor to mark the 67 degree angle on a sheet of paper so you can cut it out as a template. This template can then be used to set the angle on your handy alignment tool as shown in Figure 92.

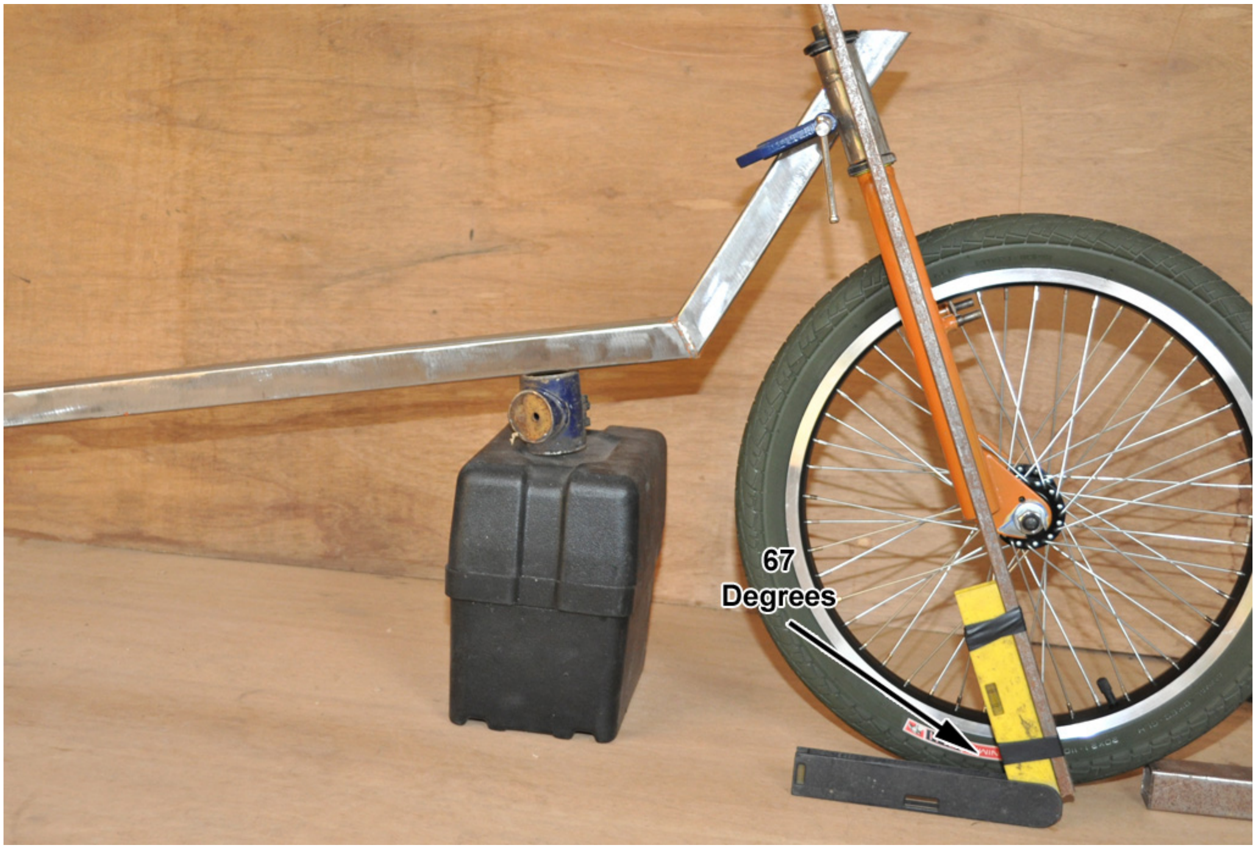


Figure 93 - Setting up the head tube angle to mark the boom for cutting

The head tube angle of a bike or trike refers to the angle between the head tube and the ground. To demonstrate this, a long metal rod is taped to an adjustable square which is placed flat on the ground as shown in Figure 93. The angle of the head tube on the Aurora Trike will be 67 degrees as shown in Figure 93. If you do not have an adjustable angle finder, you can print out the 67 degree angle from any graphics program and then cut it out as a guide. Ultra precision is again not necessary, but try to get close.

As you can see in Figure 93, the front boom will need to be trimmed, and this was done intentionally so that variances in your tire size, fork size, and head tube could be accounted for. Once you have the 67 degree head tube angle set up with the front boom placed in the center of the head tube, you can easily mark a line to trim the front boom.

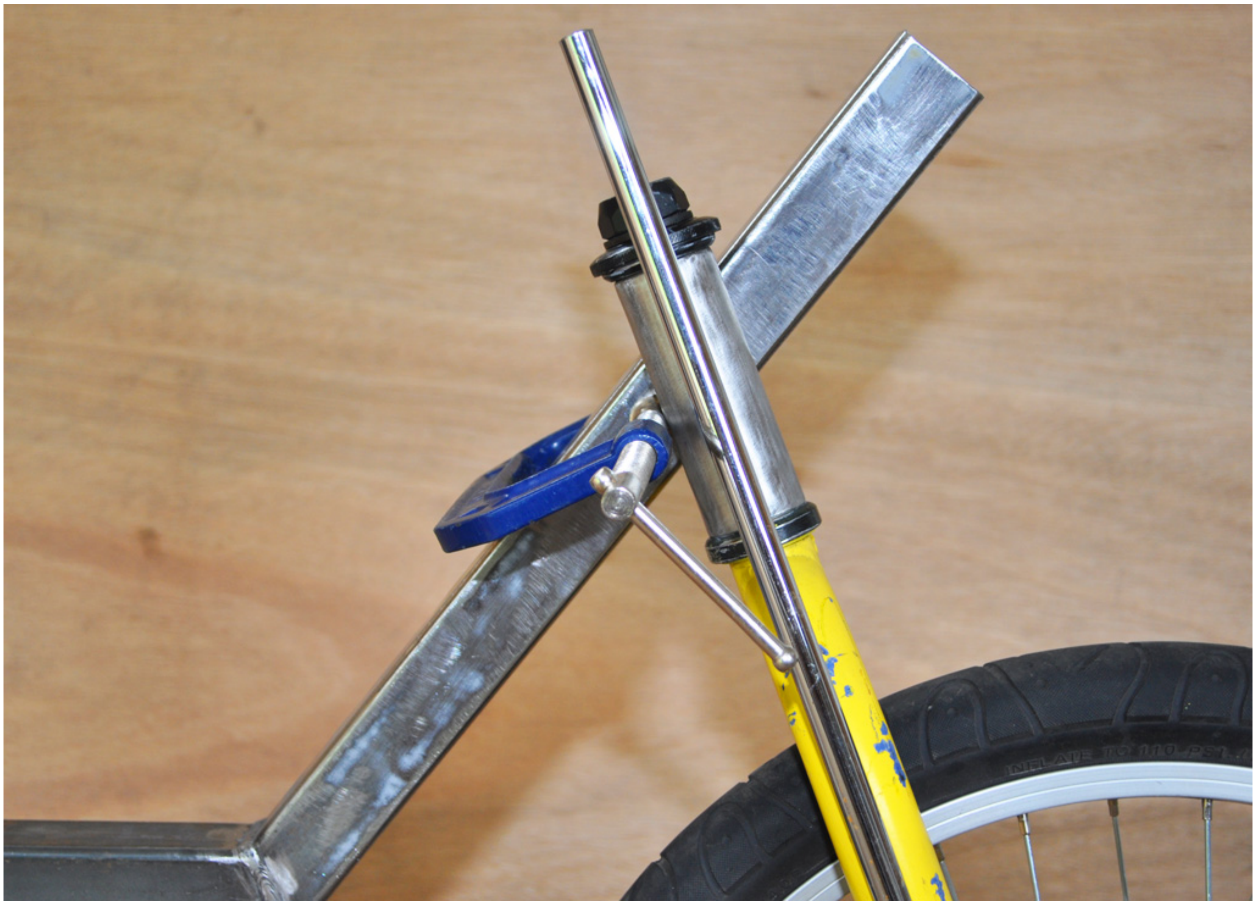


Figure 94 - The head tube is resting on the front boom clamp

The front boom tube should be intersecting the head tube somewhere in the center as shown in Figure 94. It is not critical that there be equal distance on the top and bottom of the head tube, but the bearing cups should have at least enough room between their edges and the boom tubing so that a weld can be made.

INSTALLING THE HEAD TUBE

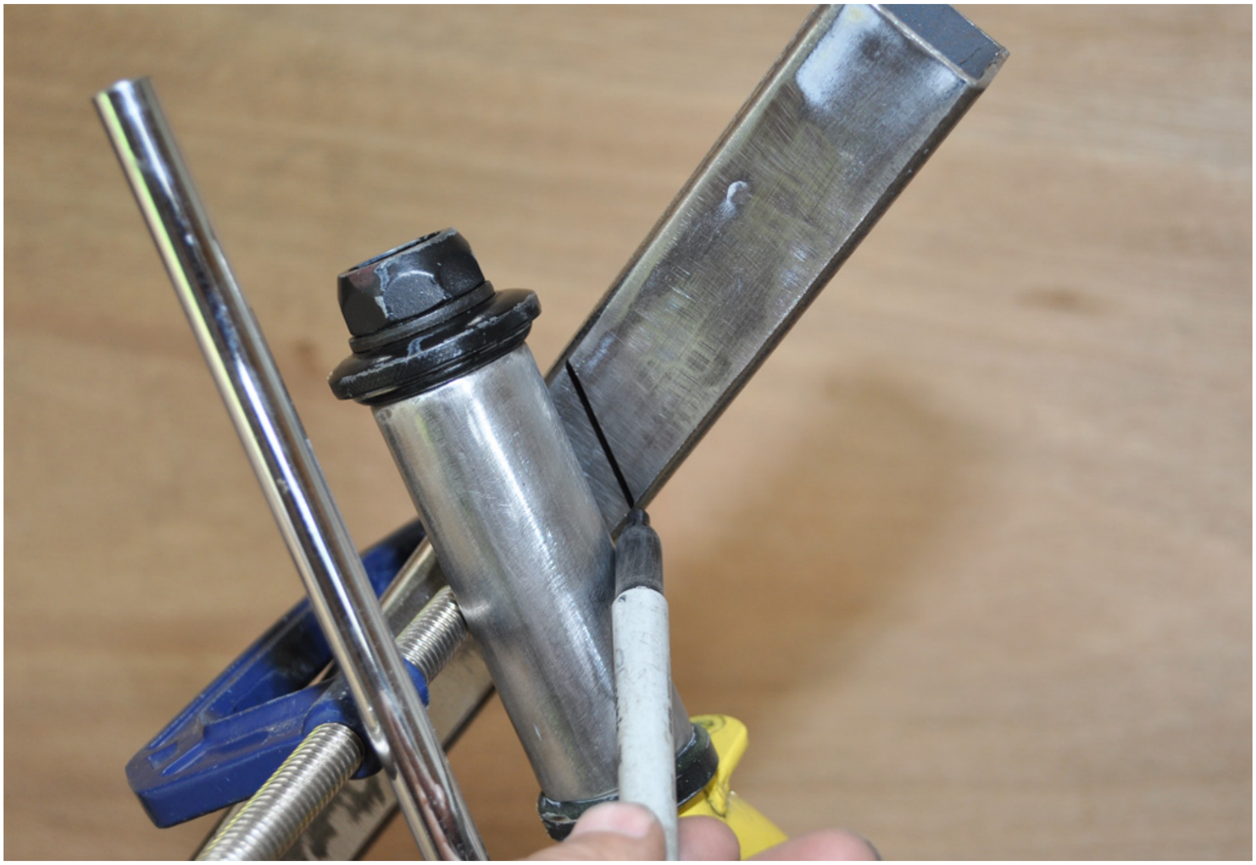


Figure 95 - Draw a cutting line in front of the head tube

The head tube will be sitting in a fishmouth cutout made on the front boom, so a line must be drawn using the head tube as a guide so you can make the cuts and fish-mouths on the top and bottom of the tubing. Draw this line ahead of the front tube as shown in Figure 95, using the edge of the head tube as a guide to draw the line.

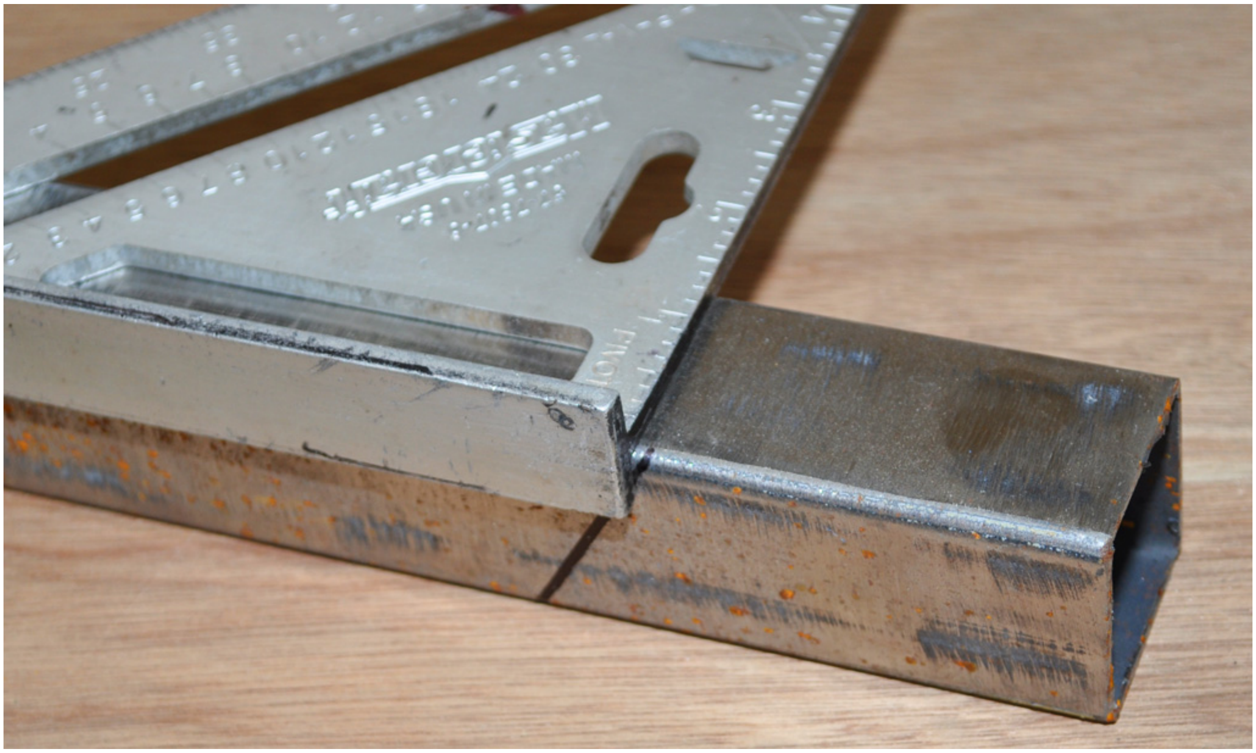


Figure 96 - Transferring the line around the front boom tube

Once you have drawn the head tube cut line as shown in Figure 95, use a square to transfer this line around the tube as shown in Figure 96. By marking a 90 degree line at the top and bottom, you can then join them together on the unmarked side, completing the head tube cut line opposite the one you originally marked.

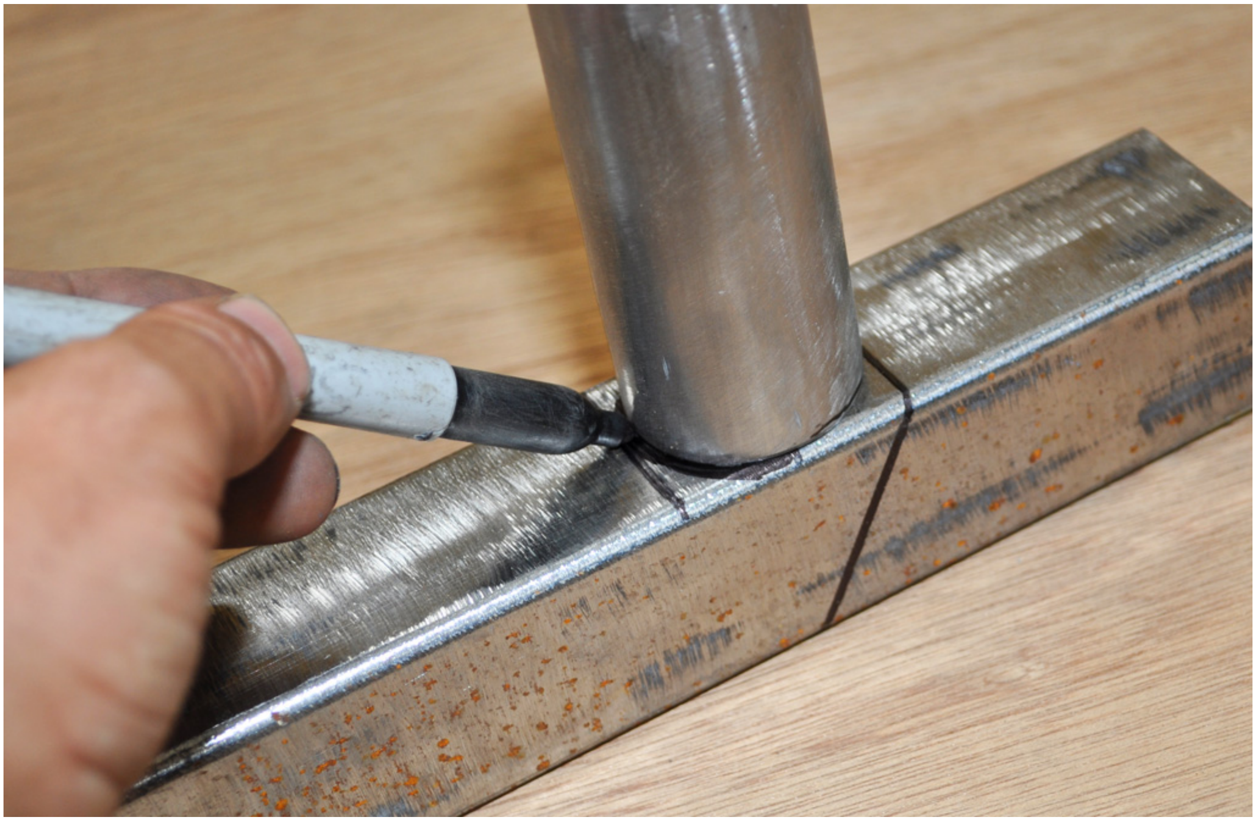


Figure 97 - Use the head tube as a guide to mark the fishmouth cut

The actual head tube will be used as a guide to trace the fishmouth cuts to be made on the top and bottom of the front boom. As shown in Figure 97, the head tube is placed just behind the line that you draw and a line is traced from edge-to-edge on the top and bottom of the front boom tube.

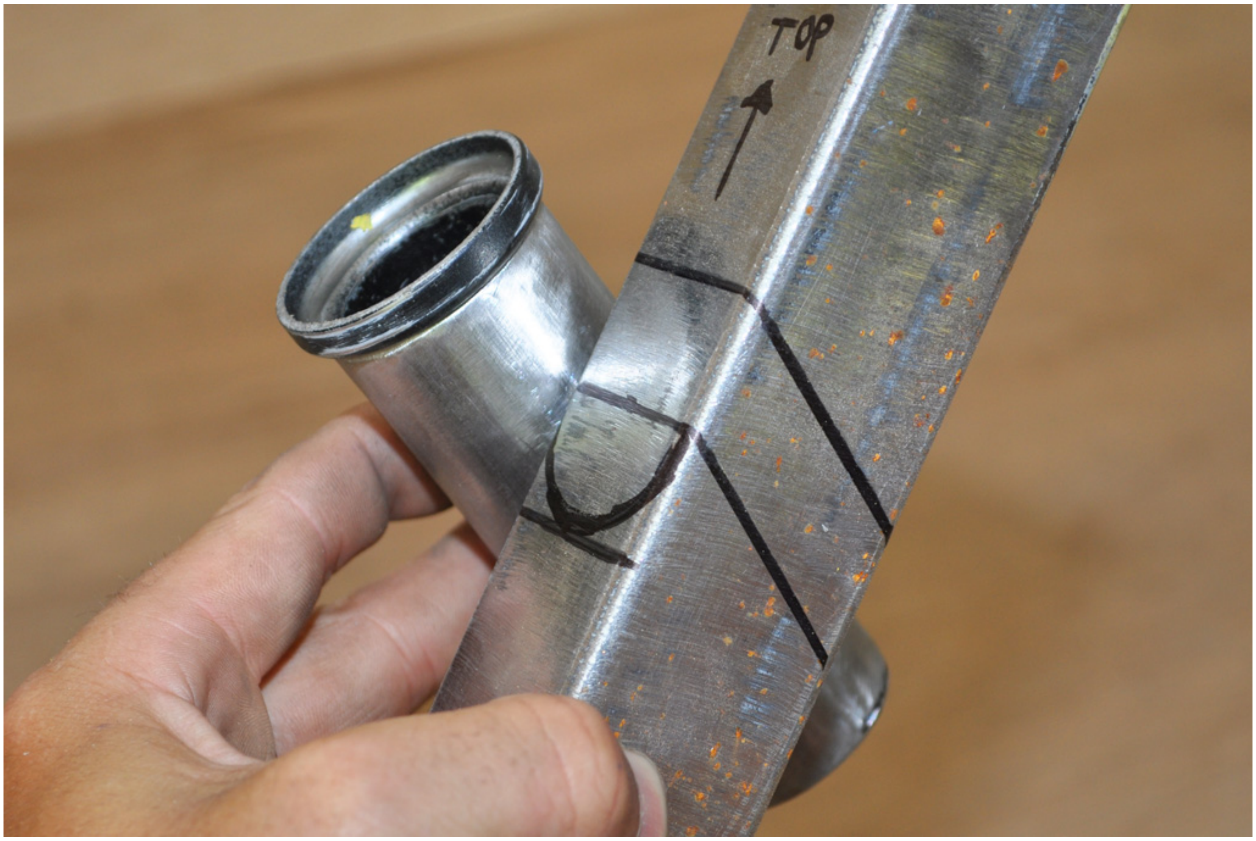


Figure 98 - Showing how the head tube will fit into the front boom tube

Figure 98 shows how the head tube will be fit to the front boom tube once the fish-mouth cuts are made. A fishmouth circle is traced on the top and bottom of the boom and then the boom is trimmed where the fishmouth meets the side walls of the tube. This boom trimming line is the second line shown that meets the corners of the fishmouth circle.

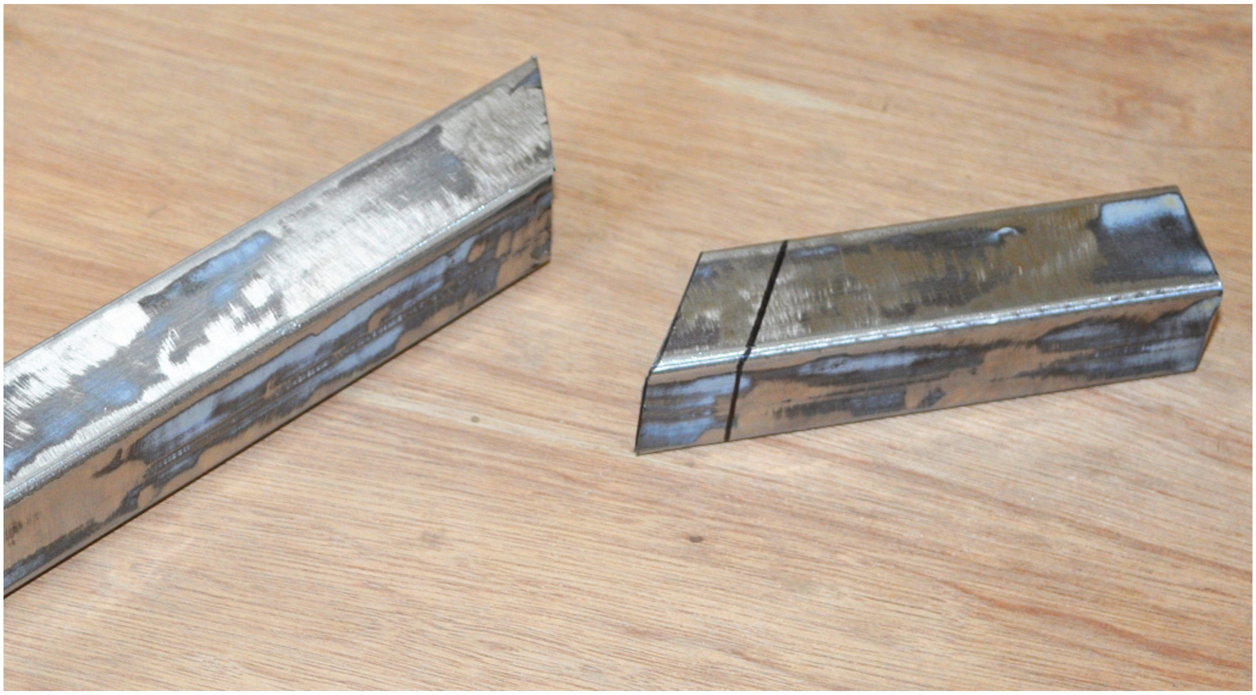


Figure 99 - Trim the front boom along the new cut line

The front boom is trimmed along the cut line that meets the edges of the fishmouth cut as shown in Figure 99. The line shown on the leftover piece was the original line drawn along the head tube shown in Figure 95.

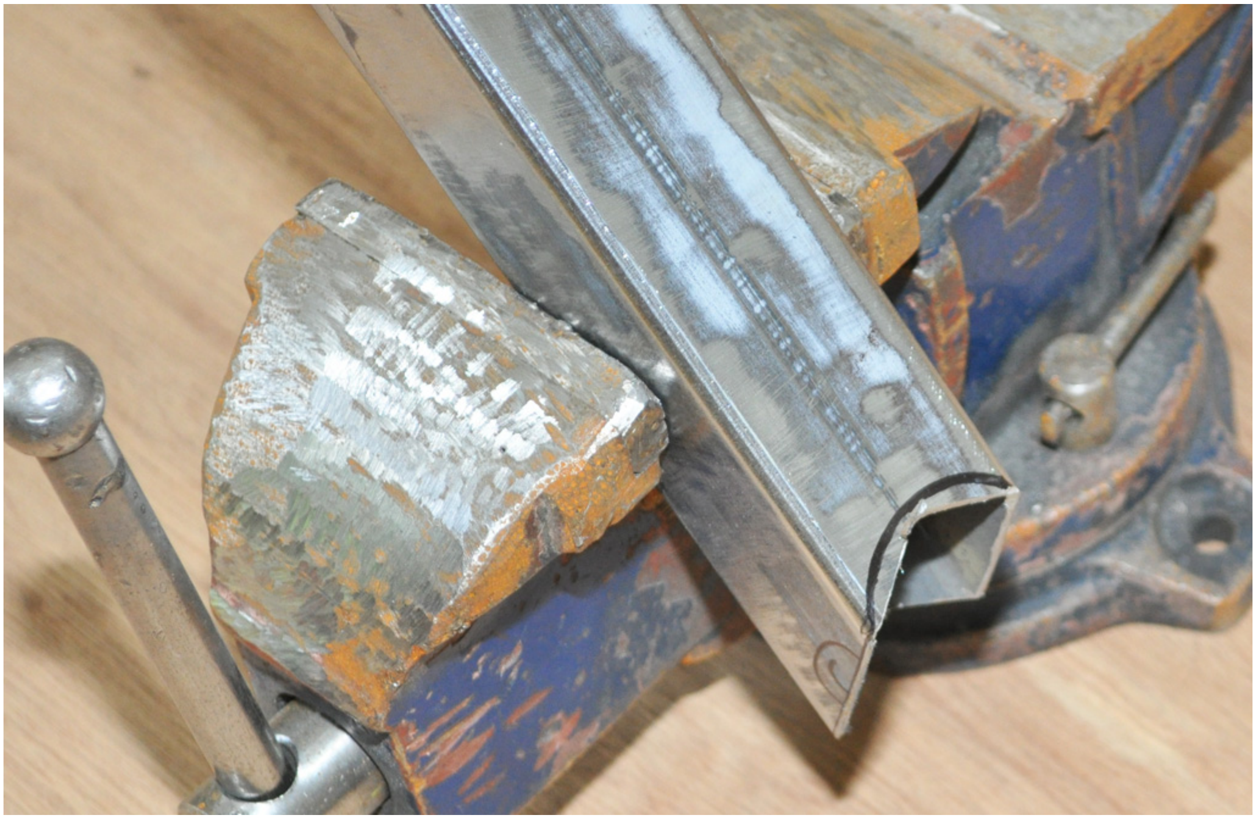


Figure 100 - Cutting out the two fish-mouth areas

Use a zip disc or hacksaw to rough cut the fish-mouth by cutting a triangle out of the tube as shown in Figure 100. This makes the final grinding easier as you only need to work to the line using a standard grinder disc or round file. To see a video tutorial of this operation, visit our website.

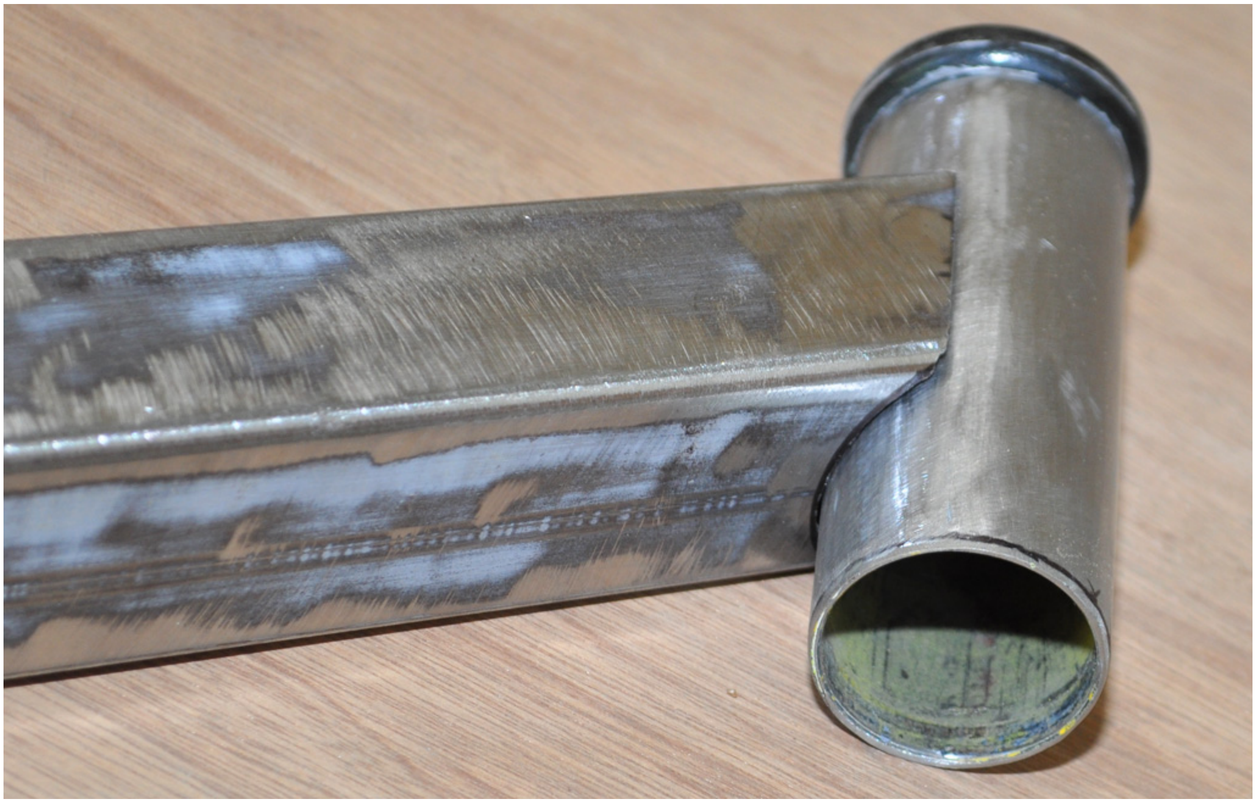


Figure 101 - Keep the gap to a minimum so welding is easier

Take care on the fishmouth cuts so that the head tube sits straight in the boom tube and so there is minimal gap in the joint. A round file is usually good for the fine tuning of the joint once the initial rough grinding has been completed. Figure 101 shows a good example of a fishmouth cut.

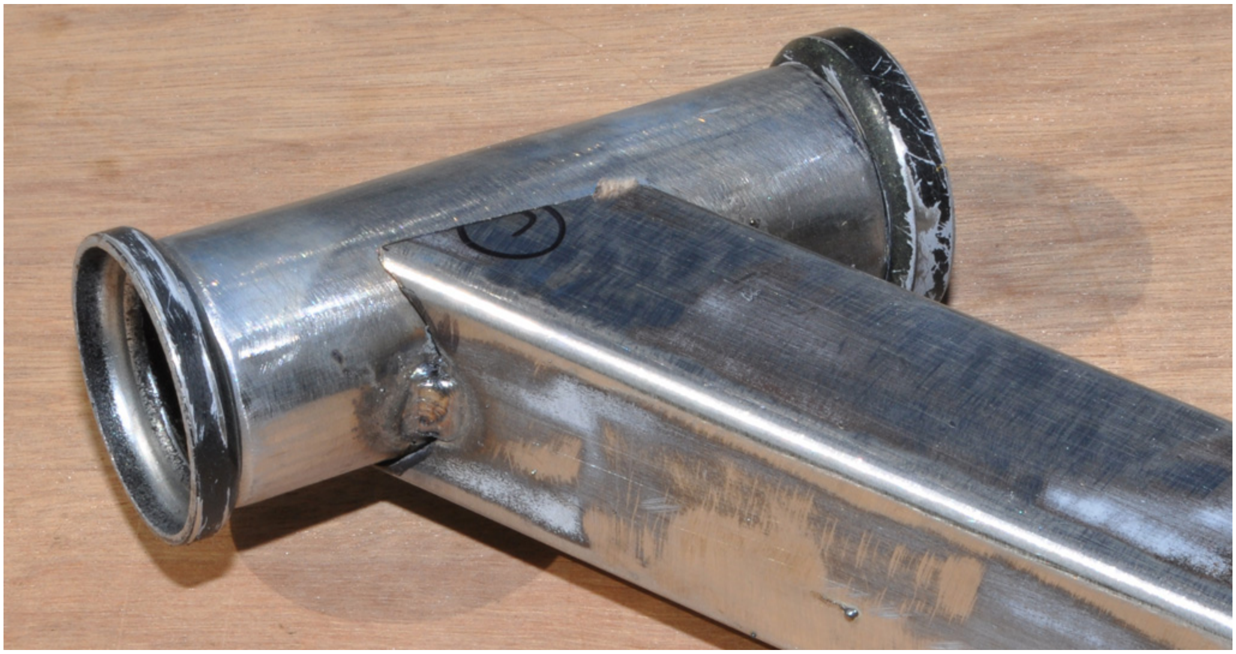


Figure 102 - Tack weld the top of the head tube and the two side corners

With the fishmouth cuts made, place the frame back up so the main boom is parallel to the ground and then sit the head tube back into the fishmouth joint as shown in Figure 103, using a wedge in front of the tire to hold it in place. The head tube will be tack welded in place right here, which will take care of any alignment problems that may have occurred during the main frame welding. The goal is to have the head tube installed at the correct 67 degree angle and standing perfectly straight up (90 degrees) from the ground.

If you find that the front forks are moving around in the head tube, remove the top bearing and then screw the race down tight. This will stop them from turning as you carefully set up the parts for tack welding. Visually inspect the frame from the front so you can ensure that all three wheels are standing up at 90 degrees from the ground.

Make a tack weld on the top of the joint as well as the two side corners once you have the alignment of the head tube set up properly. Double check the angles from all sides of the trike as you add the tack welds. Once the three tack welds are securing the head tube to the front boom (Figure 102), carefully remove the forks and so the joint can be fully welded.

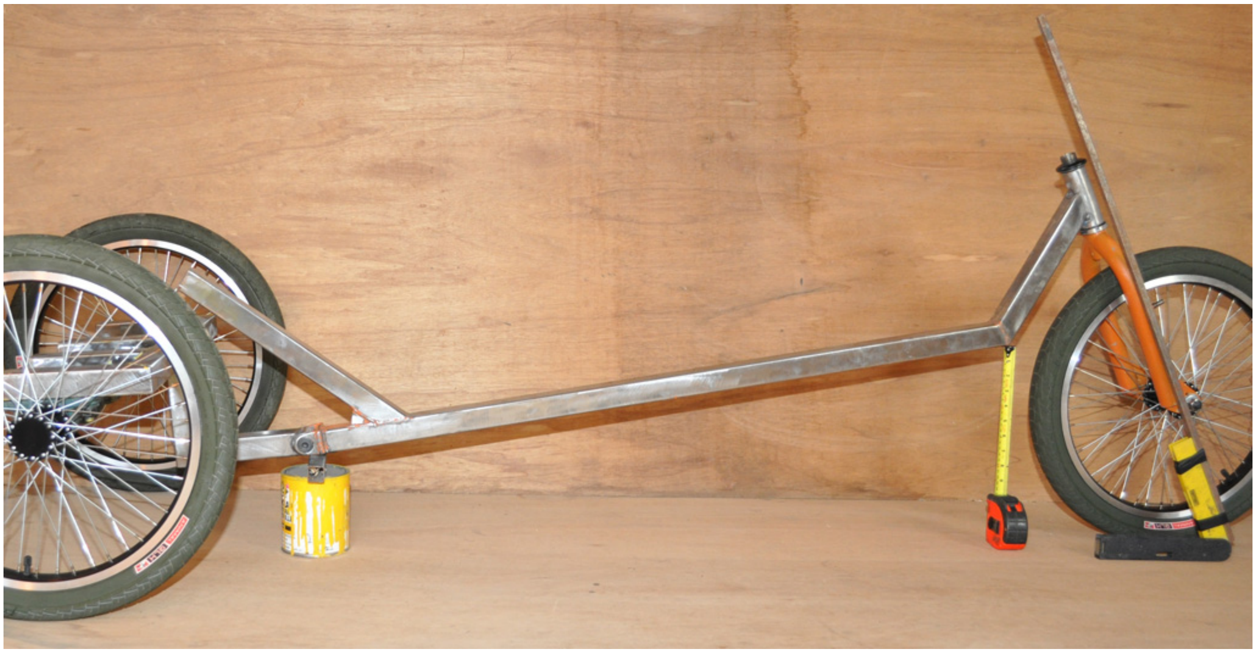


Figure 103 - Check the head tube angle before welding

It's always a good idea to check your angles right after tack welding as it will still be easy to correct any misalignment issues. Figure 103 shows the head tube alignment guide being used one last time to ensure that the head tube is set close to the desired 67 degree angle.

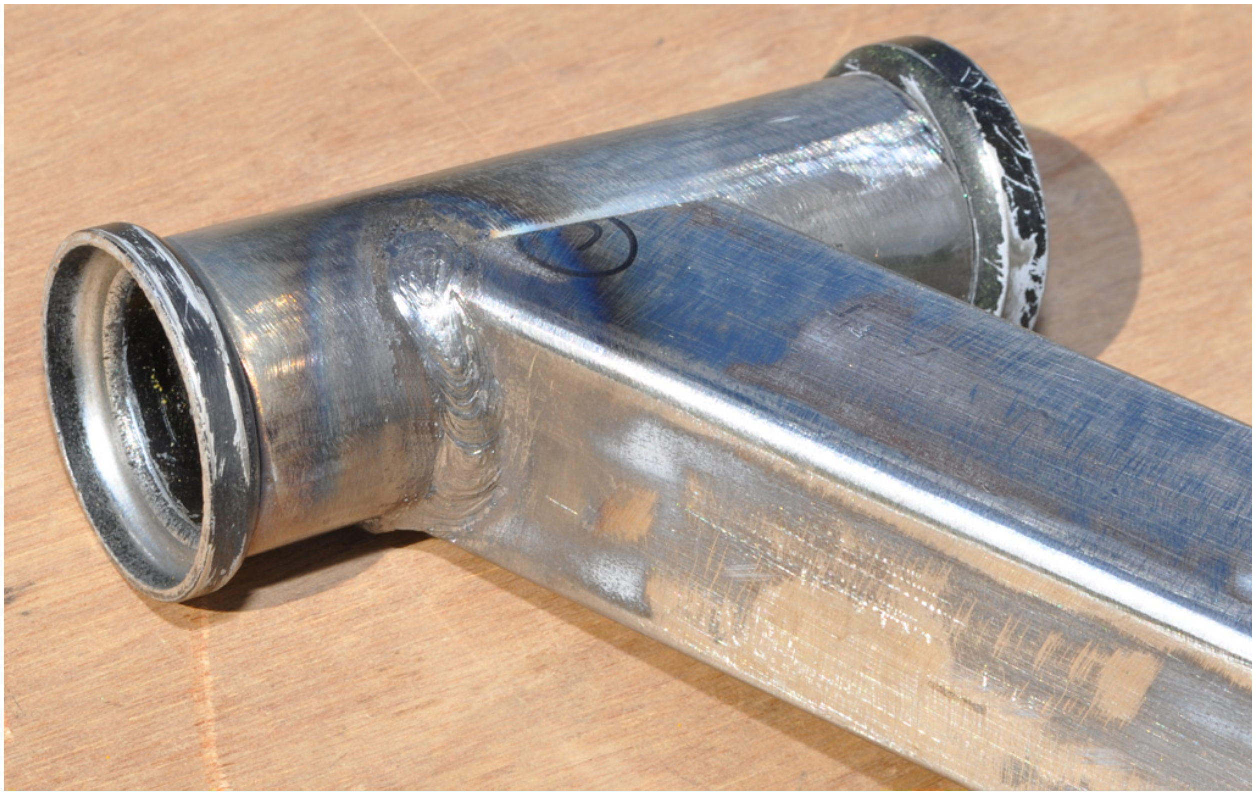


Figure 104 - Weld the top and bottom of the head tube joint first

Like all of the other angle critical joints, the head tube joint must be welded in the correct order to keep heat distortion to a minimum. The top and bottom side of the joint are welded first. To prevent the head tube from becoming slightly oval, leave the bearing cups installed as you weld as shown in Figure 104.

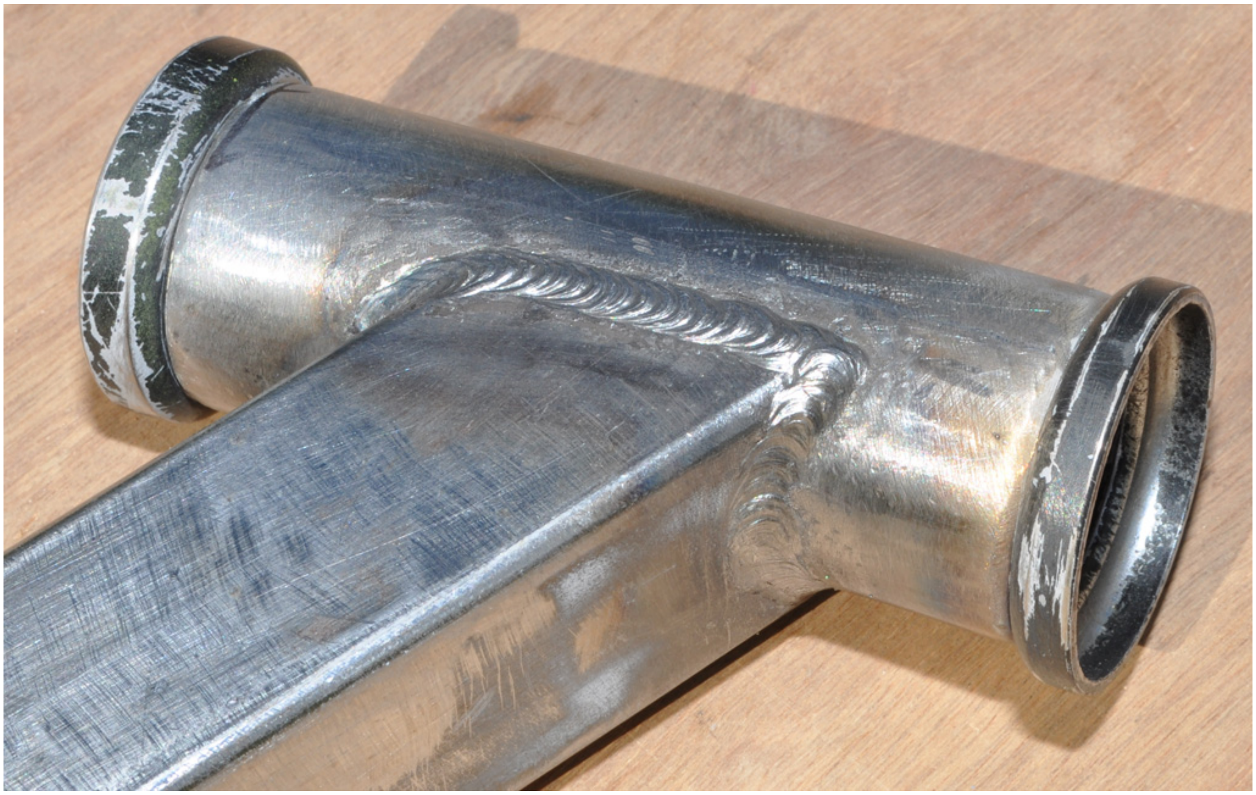


Figure 105 - The sides of the head tube joint are completed last

Once the top and bottom of the head tube joint are welded, you can safely finish the welding on the sides of the joint as shown in Figure 105. It doesn't hurt to double check the alignment one last time before welding the sides just in case something has gone wrong.

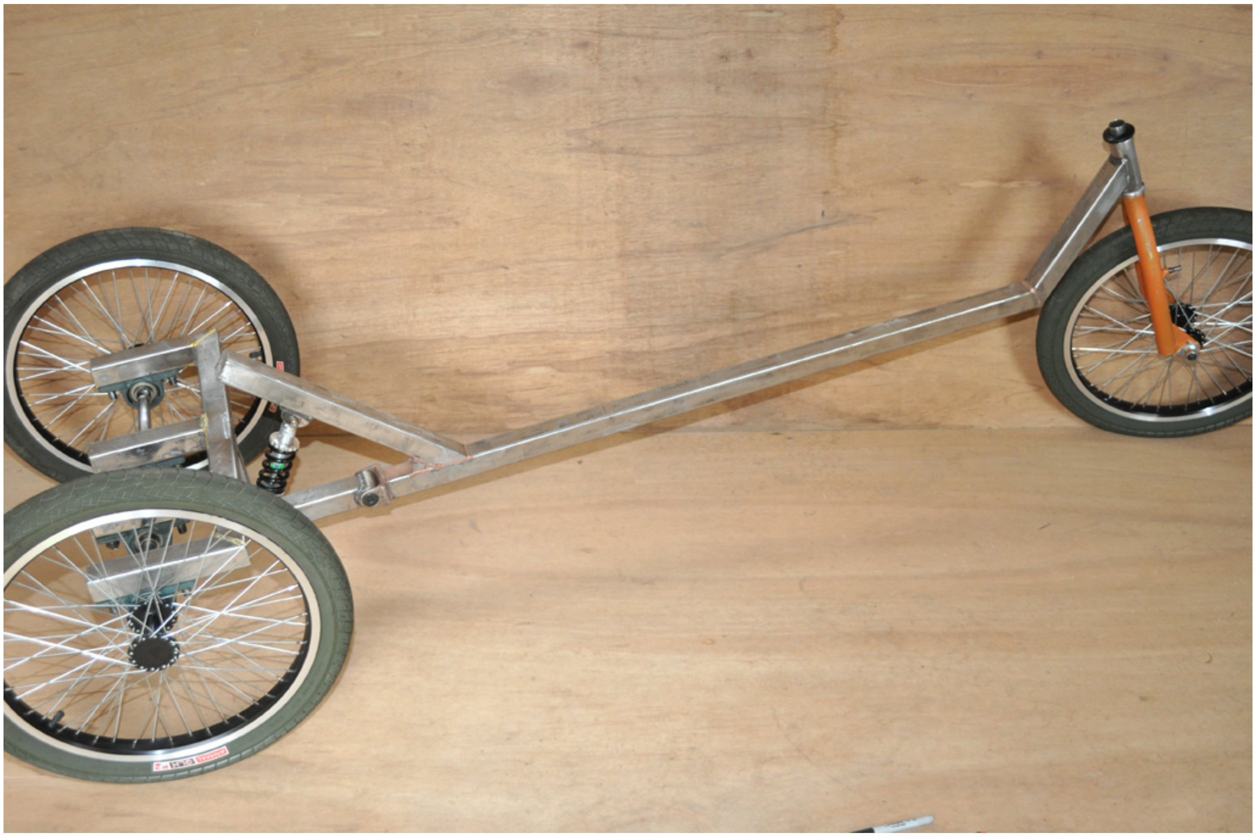


Figure 106 - You now have a rolling frame.

Congratulations - you now have a rolling frame! From here, the rest of the Aurora Trike build will seem fairly easy as all that is left are the transmission, steering, and brake parts. You initial test ride may only be a few days away now.

UNDER SEAT STEERING

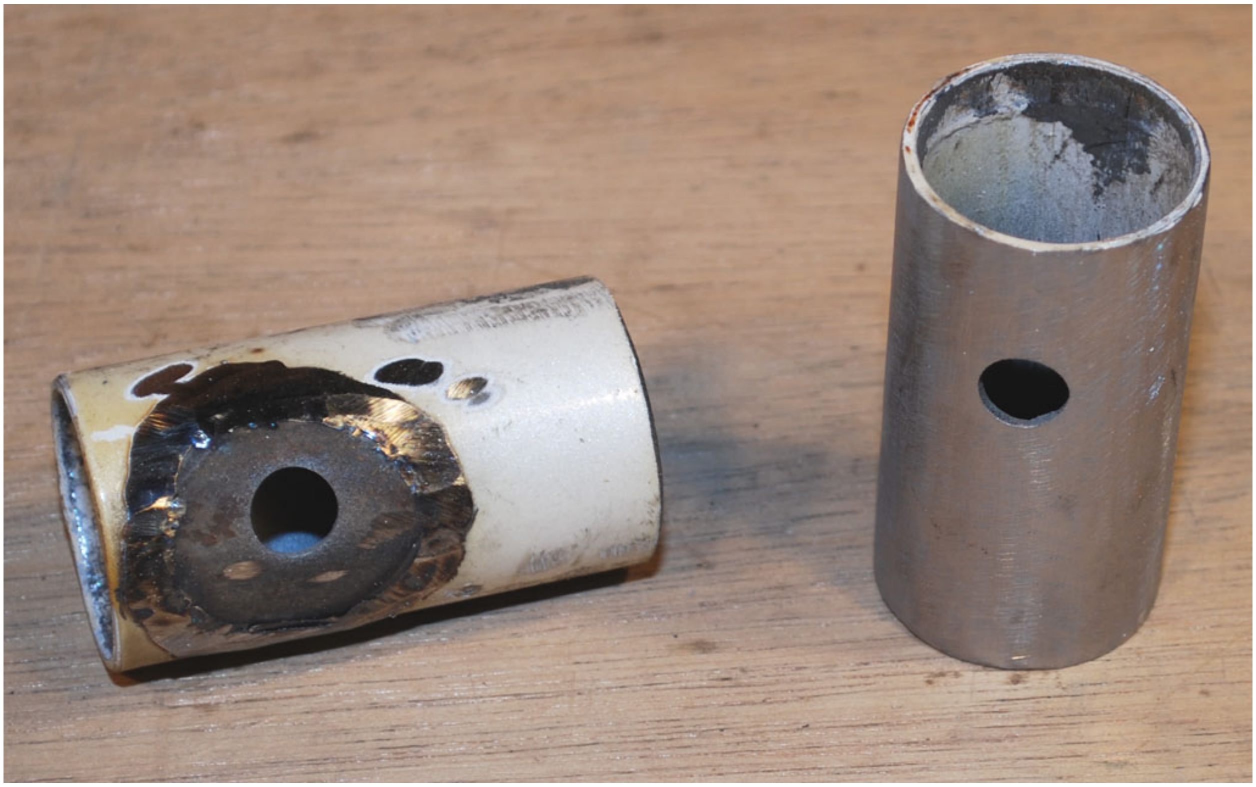


Figure 107 - Cutting a head tube down to 3 inches

The Aurora Trike features under seat steering for maximum comfort and it makes it very easy to climb in and out of the seat. This steering system links a set of handlebars mounted under the pilot's seat to the front forks through a set of control arms and a long control rod. The steering system feels completely natural and places the pilot's hands in a relaxed and comfortable position for maximal control. To create the under seat steering system, common bicycle components will be used, which will allow the use of standard handlebars, brake levers and shifting levers.

You will need a head tube, a fork stem and a steel gooseneck to create the under seat steering system for the Aurora. The head tube only needs to be 4 inches tall, so you will have to measure and cut your head tube to this length as shown in Figure 107. Grind the 4 inch tall section clean using your sanding disc.

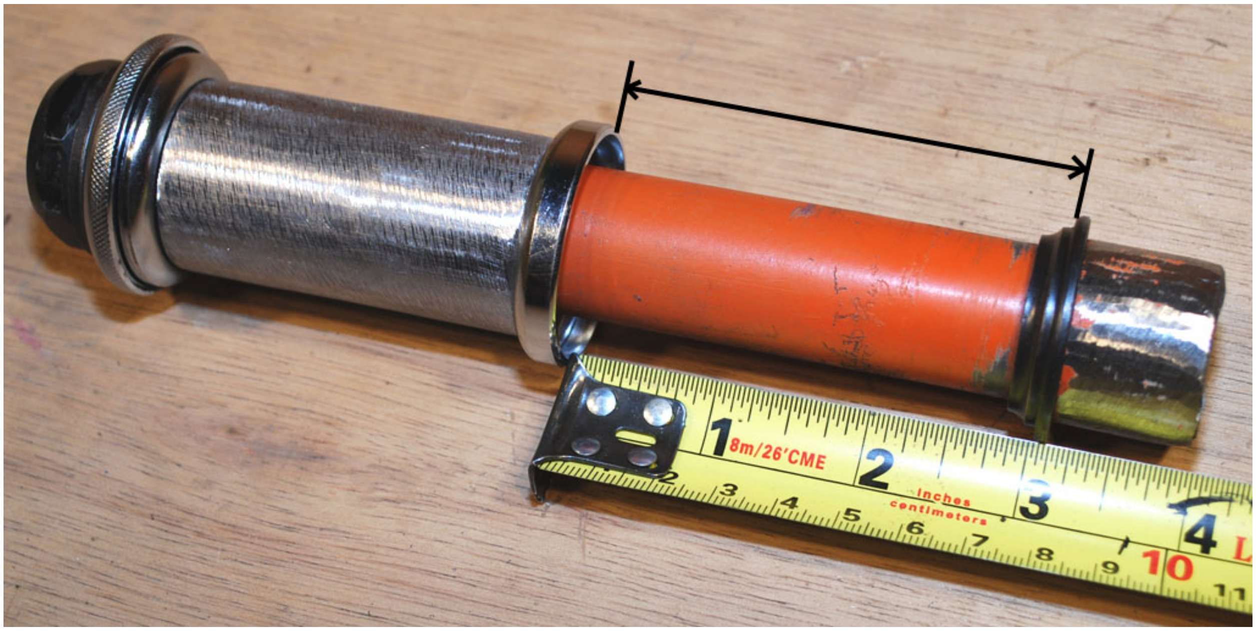


Figure 108 - Measuring the fork stem for cutting

You will not require the fork legs, so cut them away at the crown area and then grind the surface clean as shown in Figure 108. You will also need to shorten the fork stem once the head tube has been cut down to the required 4 inch height. To determine how much of the fork stem needs to be removed, install the all of the top hardware including the bearing and then measure the distance from the bottom of the lower cup to the top of the fork stem bearing race as shown in Figure 108.

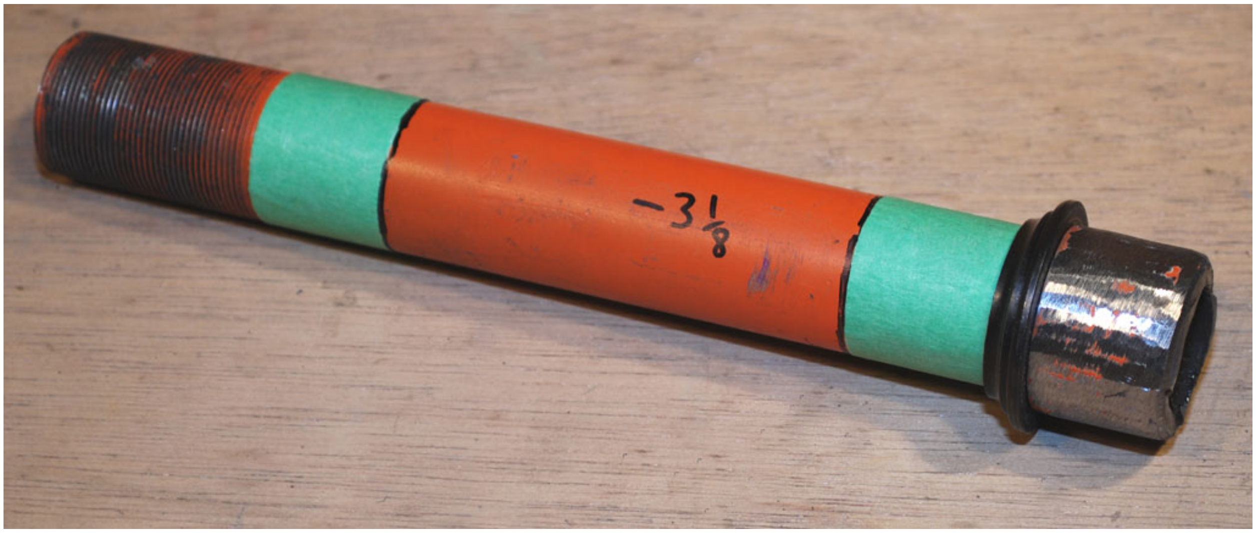


Figure 109 - Marking the fork stem for cutting

My fork stem needed to be cut down by 3 and 1/8 inches as determined by the step shown in Figure 109, so I marked the section to be cut. The fork stem needs to be shortened in the center so you are not trying to weld over either the threaded section or right at the bearing race. If you do not have an inexpensive pipe cutting tool, wrap some tape around the line to be cut as this will help you cut around the area in a more precise manner.

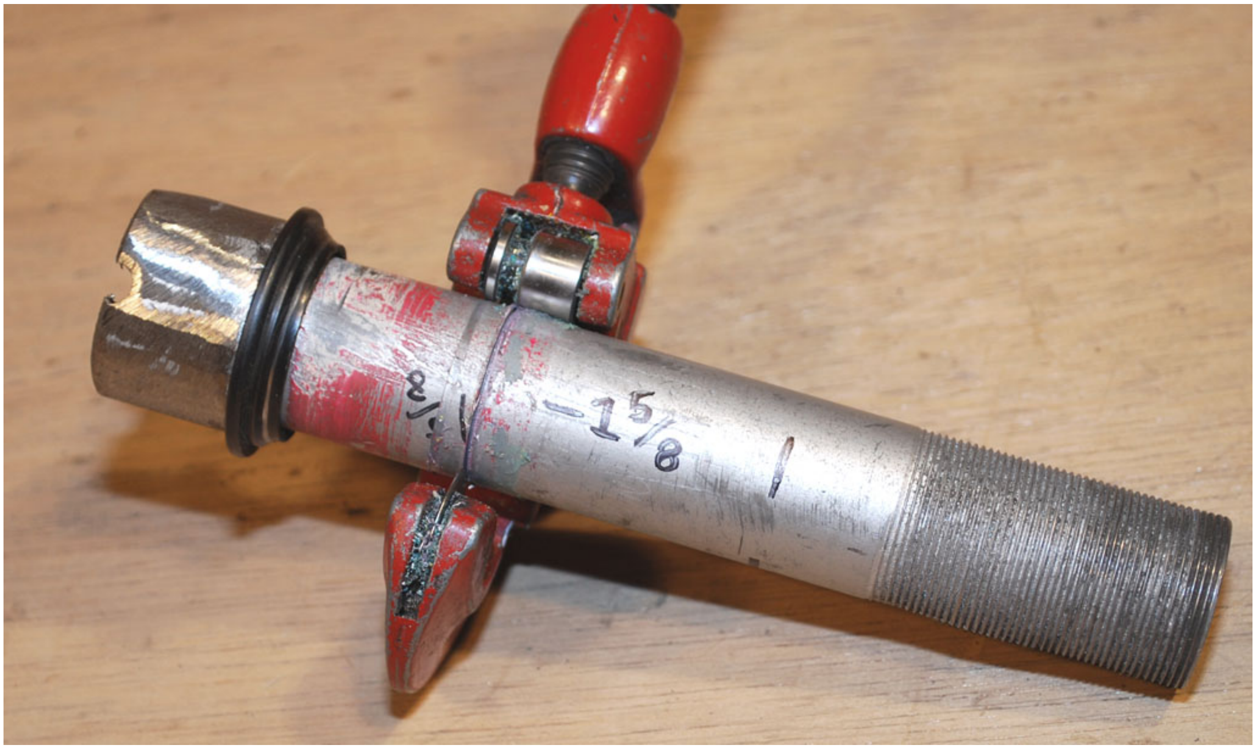


Figure 110 - Cutting the fork stem using a tube cutter

The inexpensive tubing cutter shown in Figure 110 is an extremely useful tool as it makes a perfect cut with minimal effort. It is important to make an accurate cut on the end of the round tubing because it will need to be fit back together for welding.

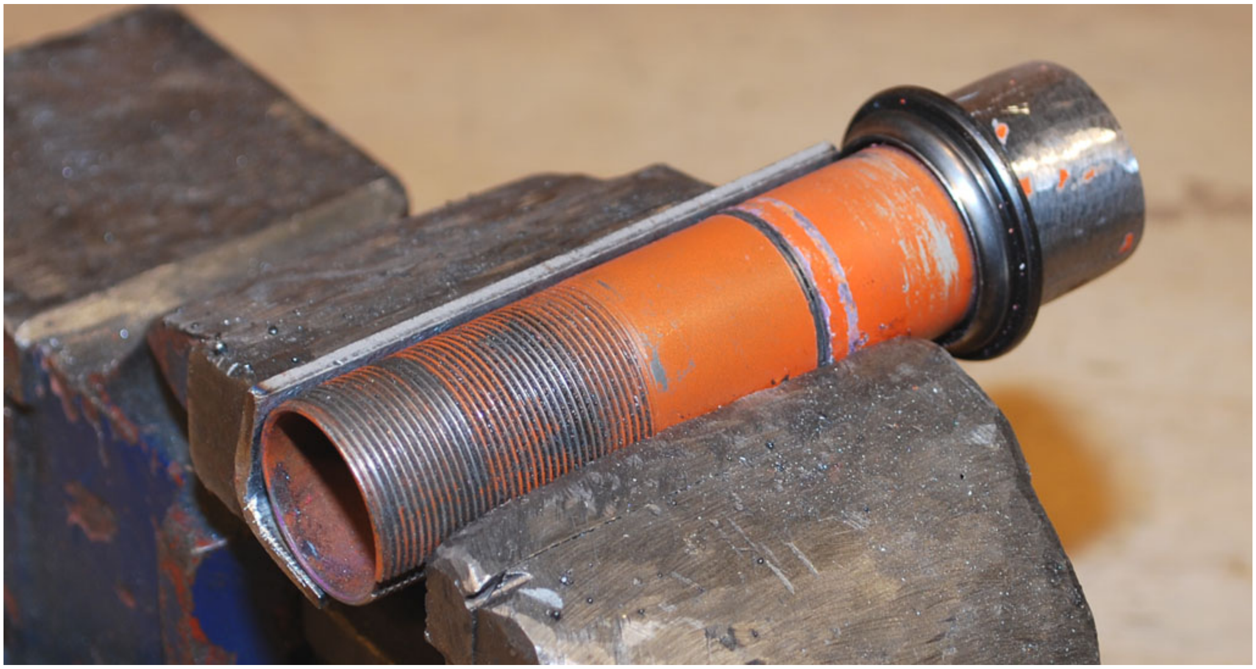


Figure 111 - Setting up the fork stem halves for rejoining

To ensure that the two fork stem halves are rejoined in an accurate manner, place them inside a piece of angle iron and into a vice as shown in Figure 111. You can then make several tack welds to secure the alignment and then release the part for further welding.

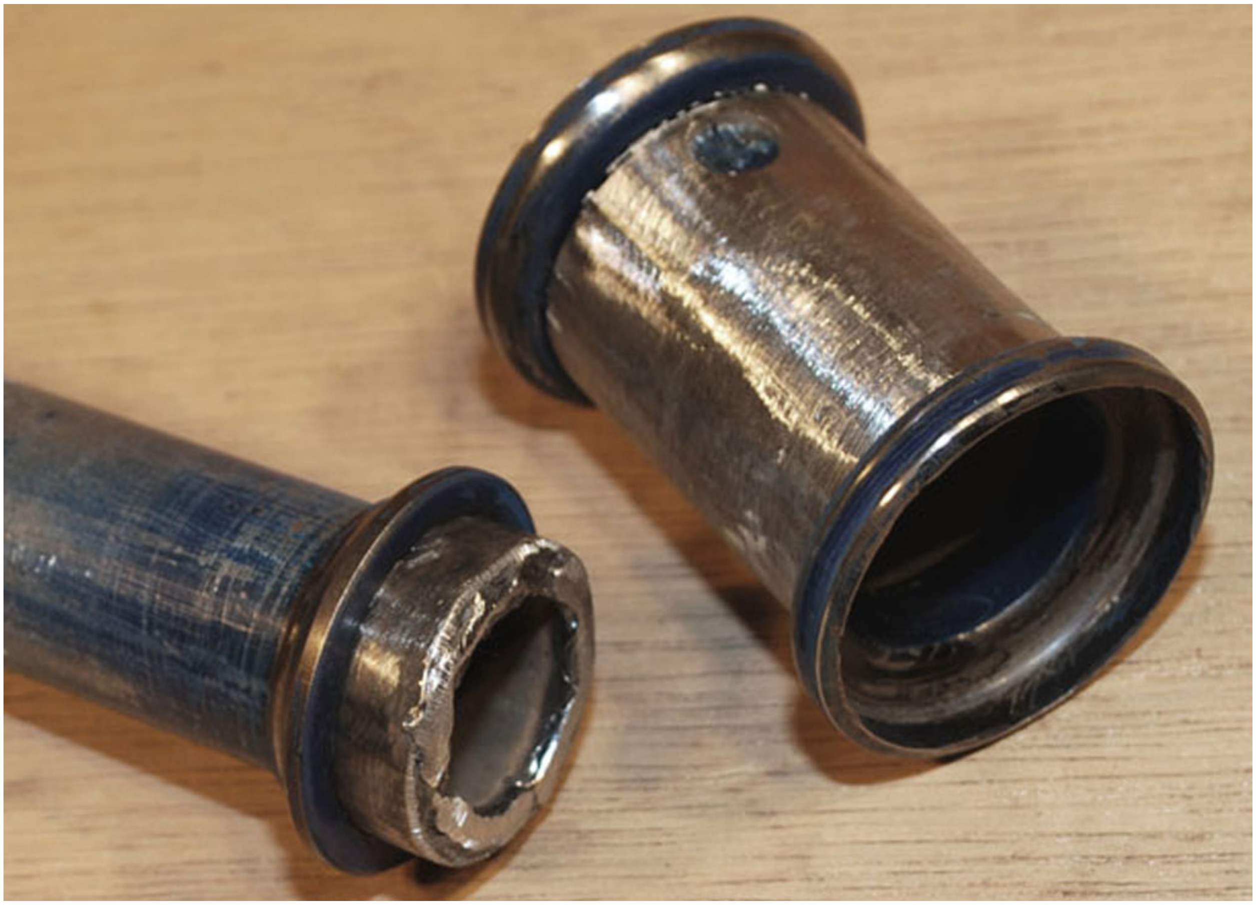


Figure 112 - Run a bead of weld on the underside of the fork stem

You can also cut some of the fork stem area down so that the crown is only half an inch long, but you will need to run a bead of weld around the underside as shown in Figure 112 because the crown area is actually made up of two tubes that are press fit into each other. If you do not intend to shorten the crown area, then this extra welding can be omitted.

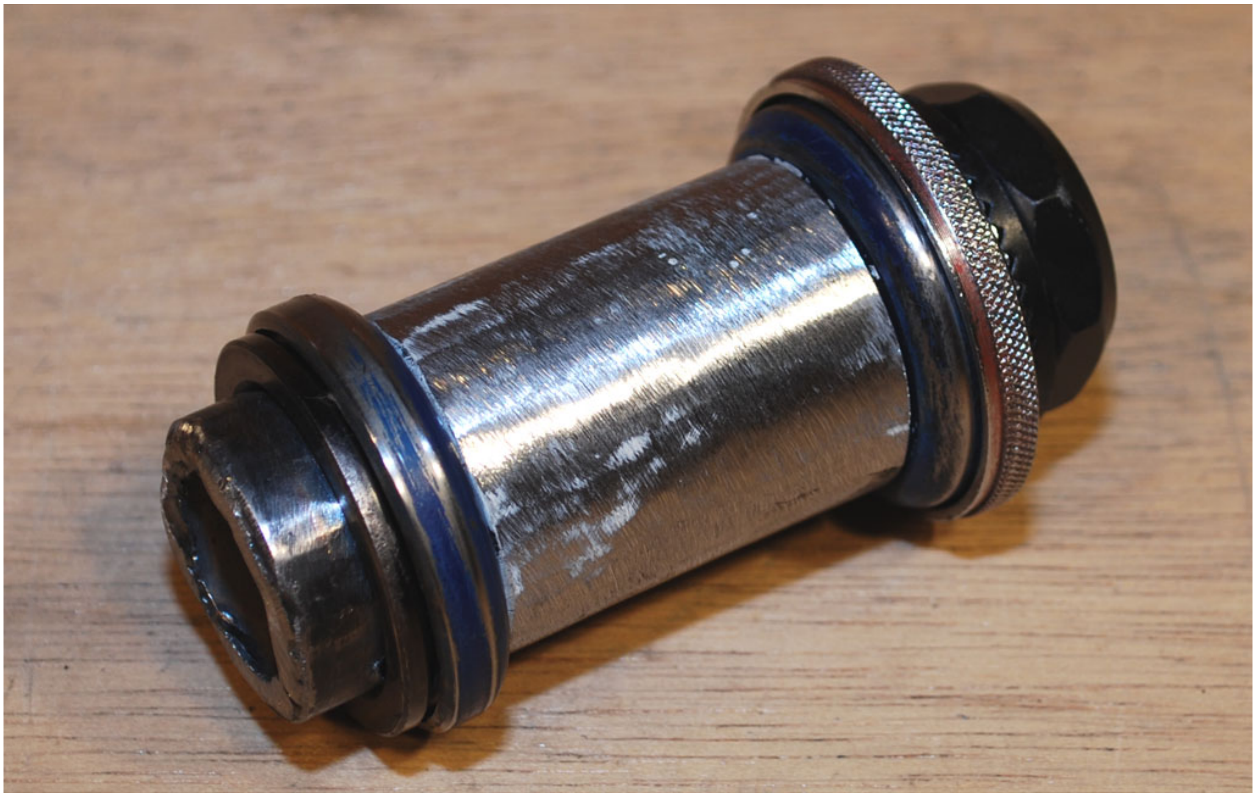


Figure 113 - The completed steering assembly after being shortened

The new miniature head tube and fork stem assembly is shown in Figure 113 after being shortened and reassembled. Ensure that all of the bearing hardware fits together properly so that the stem can spin freely once all of the hardware is installed and tightened.

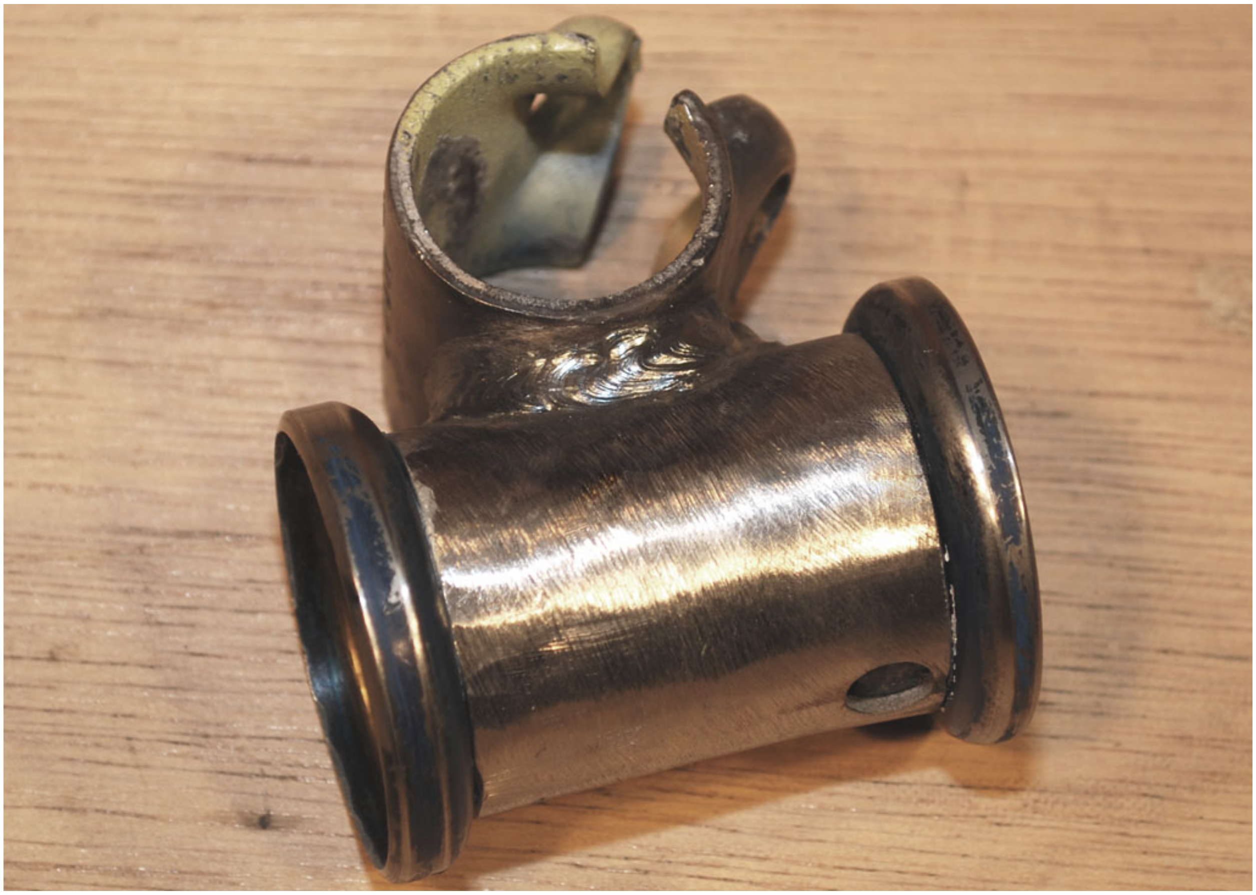


Figure 114 - The handlebar clamp is welded to the pilot's head tube

To allow for the installation of standard or modified bicycle handlebars, a steel gooseneck is cut up for the clamp, which is shown welded to the pilot's head tube in Figure 114. This clamp is placed in the center of the head tube and needs to be aligned so that the handlebars are parallel to the ground. Use a straight handlebar installed in the clamp as a guide to help when aligning the clamp on the head tube shell.

STEERING LINKAGE

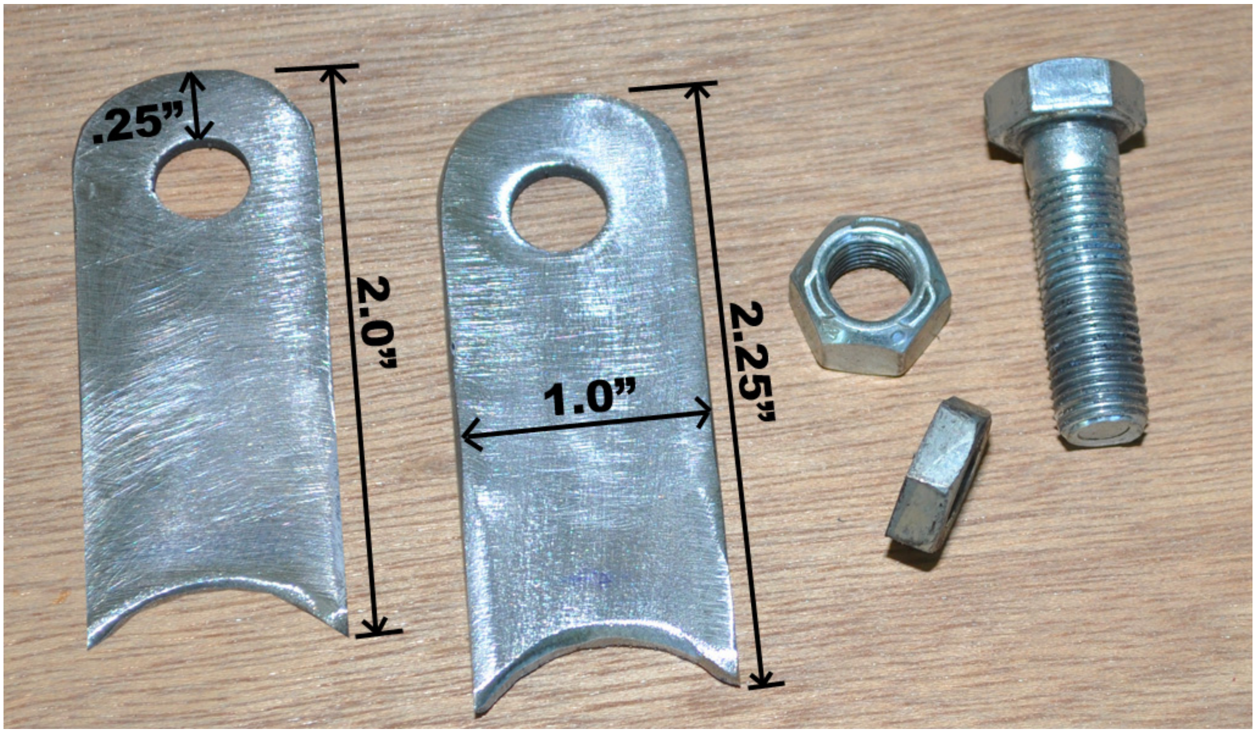


Figure 115 - The steering control arms

The pilot's steering system connects to the front steering system through a pair of control arms, a spherical bearings (ball joints) and a control rod. The two control arms are shown in Figure 115 and are made from lengths of 1 inch wide, 1/8 or 3/16 inch thick flatbar. Notice how one control arm is slightly shorter than the other. The short control arm (2 inches) will be connected to the front forks while the longer control arm (2.25 inches) will be connected to the pilots head tube. This difference in length creates a small mechanical advantage in the steering system to allow for a more full range of steering with less handlebar rotation.

The bolt holes in the control arms are made to whatever size bolt holes your ball joints require, and the hole is placed on the control arm so that there is about a quarter inch of space from the end of the part. The fishmouth cut made at the bottom of each control arm is made to conform to the head tube shell and fork leg where they will be attached.

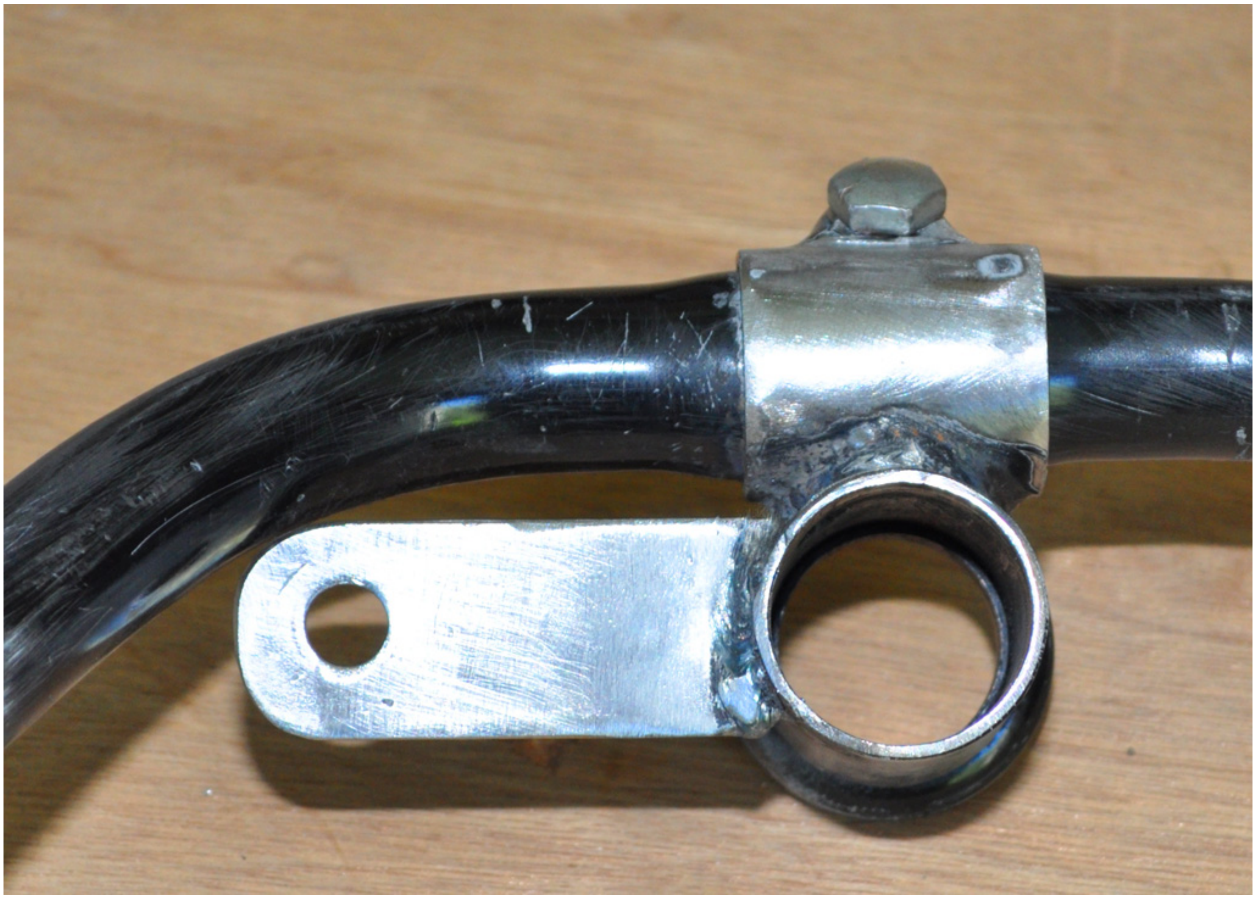


Figure 116 - Installing the pilot’s side control arm

The pilot’s side control arm (the longer one) is welded to the left side of the pilot’s head tube shell as shown in Figure 171. If you look ahead, you can see how the control rod is placed on the left side of the trike to sneak along the frame between the boom and the left crank arm. The control arm is welded so that it is at 90 degrees to the frame tubing as shown in Figure 171. The control rod will be placed over the handlebar tubing, so place the control arm up high enough to account for this. It is a good idea to only tack weld all of the steering parts together at first and then complete the welding once you have the steering working the way you like.

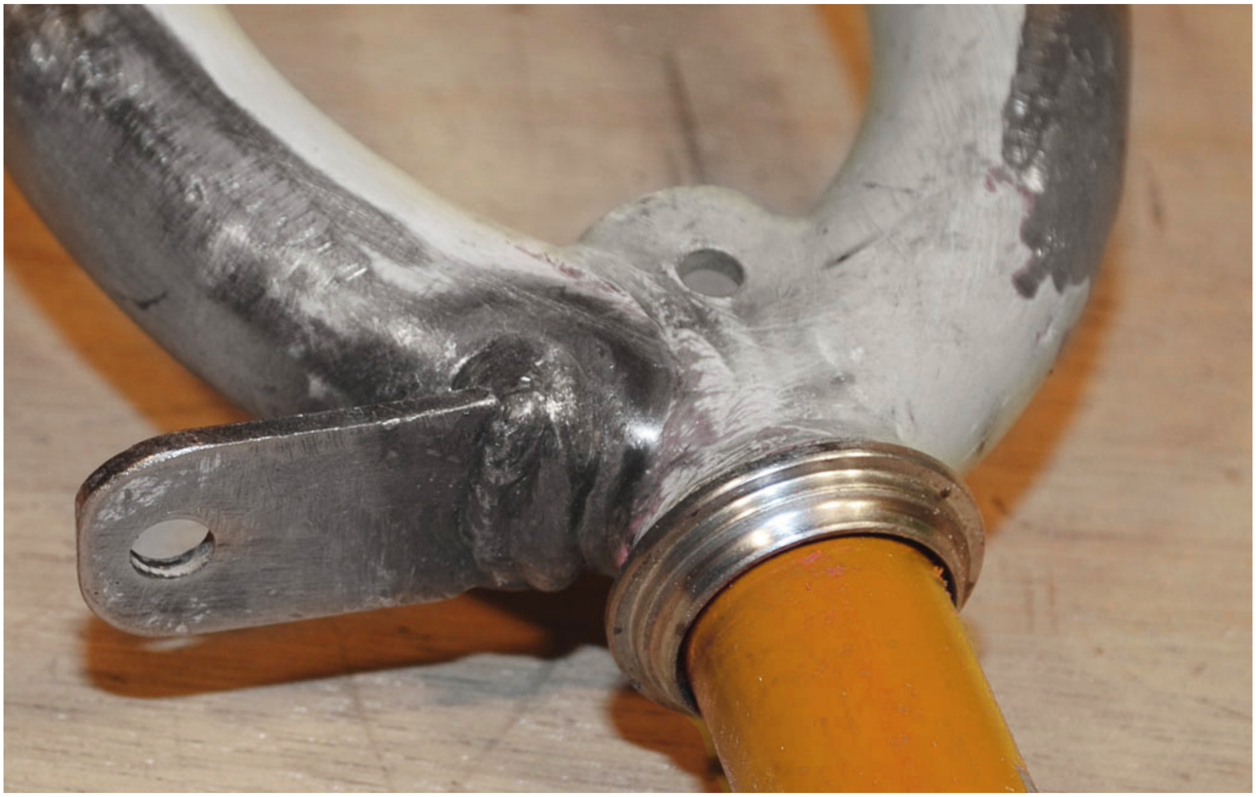


Figure 117 - Installing the front fork control arm

The front fork control arm (the shorter one) will be installed on the left side of the front forks at 90 degrees as shown in Figure 117. The face of the control arm should angle slightly as if drawing a line back to the pilot's control arm so that the ball joints and control rod can sit flat on both control arms. Place the front fork control arm up near the fork crown, and remove the bearing race when welding to avoid damage. Remember, the control arm lives on the left side of the trike since the front crank chain rings would be in the way on the right side of the frame.

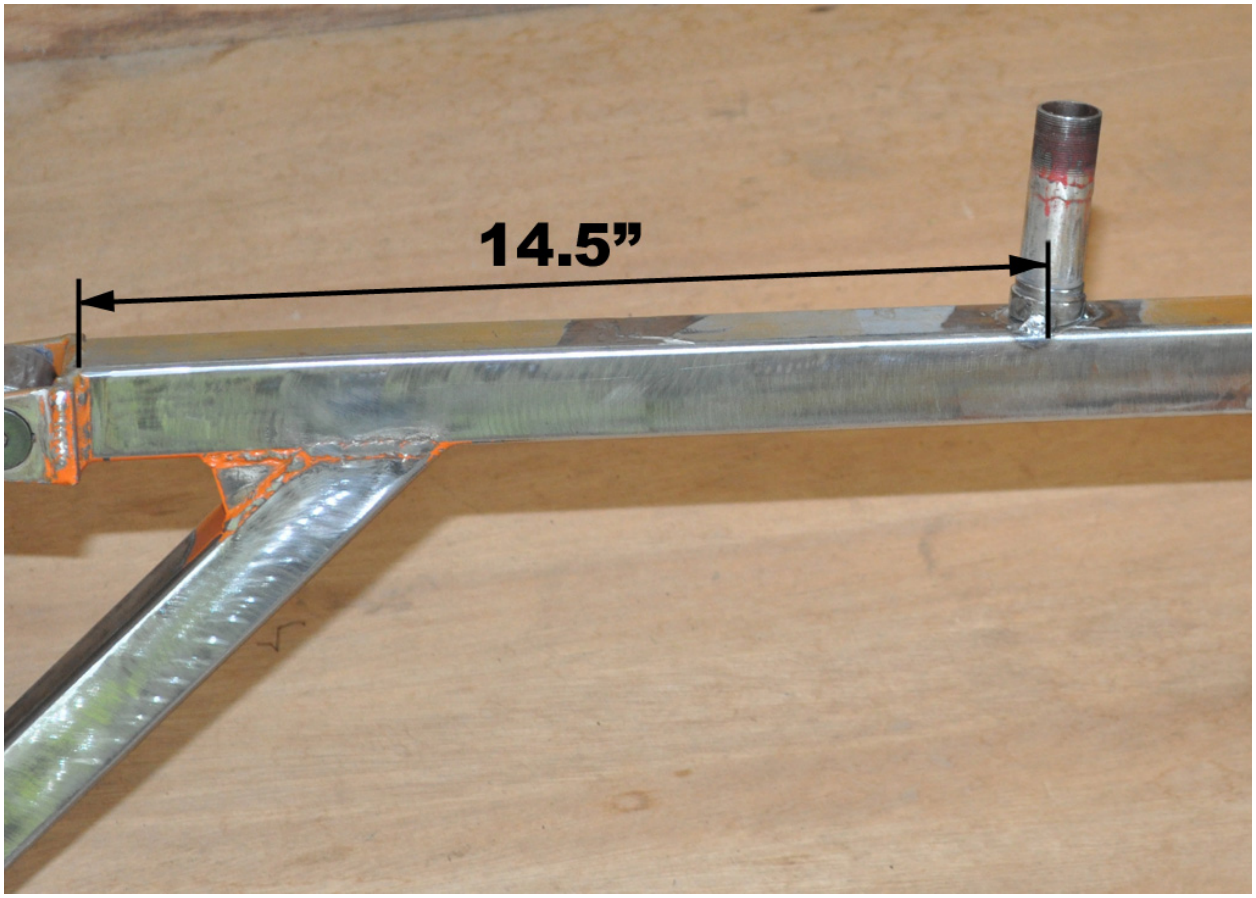


Figure 118 - Installing the pilot’s fork stem under the seat

The pilot’s steering system lives directly under the seat about 14.5 inches from the end of the boom tubing as shown in Figure 153. You will notice that the stem has been installed at a slight angle, leaning approximately 5 to 10 degrees towards the front of the trike, which in Figure 118 would be to the right of the photo. This slight angle helps align the steering control arms between the front forks and pilot’s steering system. For now, tack weld the pilot’s fork stem under the seat riser tube at the slight angle shown in Figure 118. Tap off the bearing race when welding so that you do not accidentally damage it during the welding process.

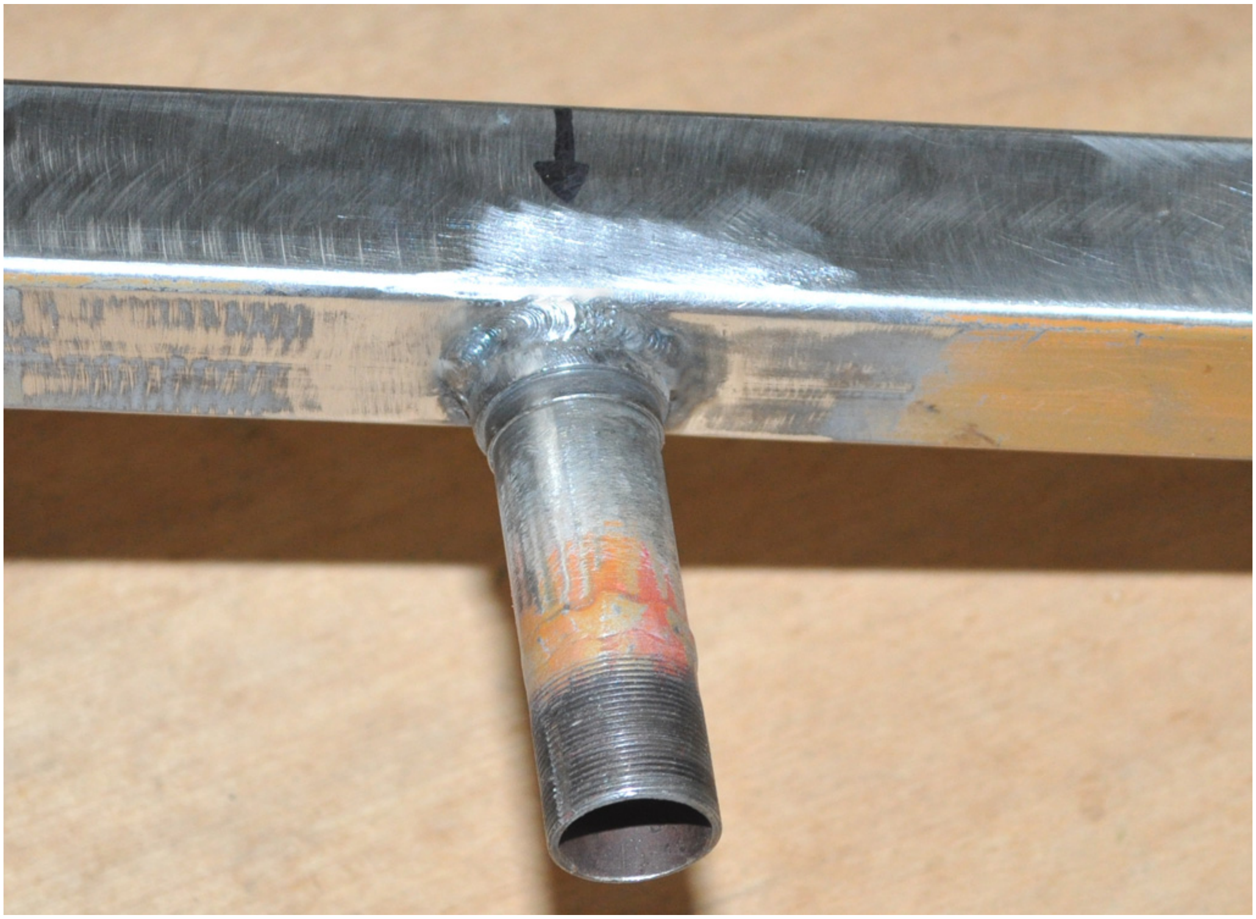


Figure 119 - Welding the fork stem to the frame

Once you have the fork stem firmly tack welded to the frame, install the steering bits and a set of straight handlebars so you can ensure that they are parallel to the ground, and not leaning to either side of the frame. The slight forward angle of the fork stem is expected, but there should not be any side to side leaning, as that would make one side of your handlebars higher than the other. Once you have checked the alignment, weld all the way around the joint as shown in Figure 119. You can now install the steering hardware once again in order to determine the optimal length to make the control rod.

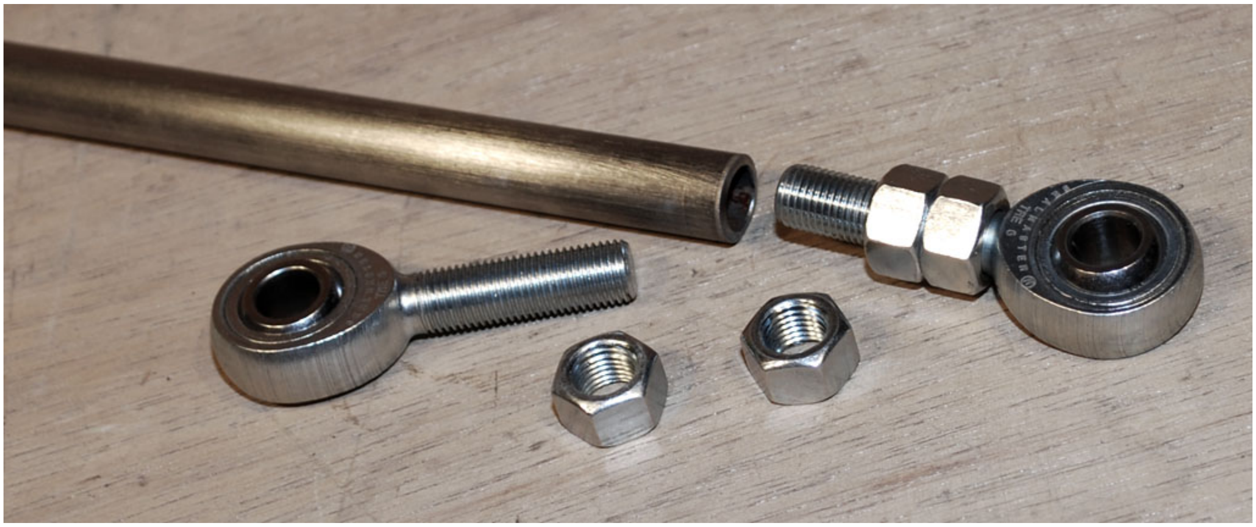


Figure 120 - Ball joints, and a control rod link the steering system

The steering control arms are linked together by a control rod with two ball joints (a spherical bearings) at each end. The steering on the Aurora Trike feels no different than that of a regular bicycle since the operation of the linkage is almost transparent to the pilot. A control rod made from a length of hollow ½ inch tubing will have a pair of ball joints mounted at each end so that the two front control arms are linked together. Because the ball joints can be screwed into the rod, slight steering alignment fine tuning is possible as well.

The ball joints or a spherical bearings are rated by their bolt hole size. The ones I always use are made for a 3/8 bolt, and include a bolt body so that they can screw into the nut welded at the end of the rod. It’s easy to calculate how long to make the steering control rod by setting the front wheel and handlebars in the straight ahead position and measuring the distance between the hole centers on both control arms.

This hole-to-hole distance between control arms should match the hole-to-hole distance on the control rods ball joints once you assemble the control rod system.

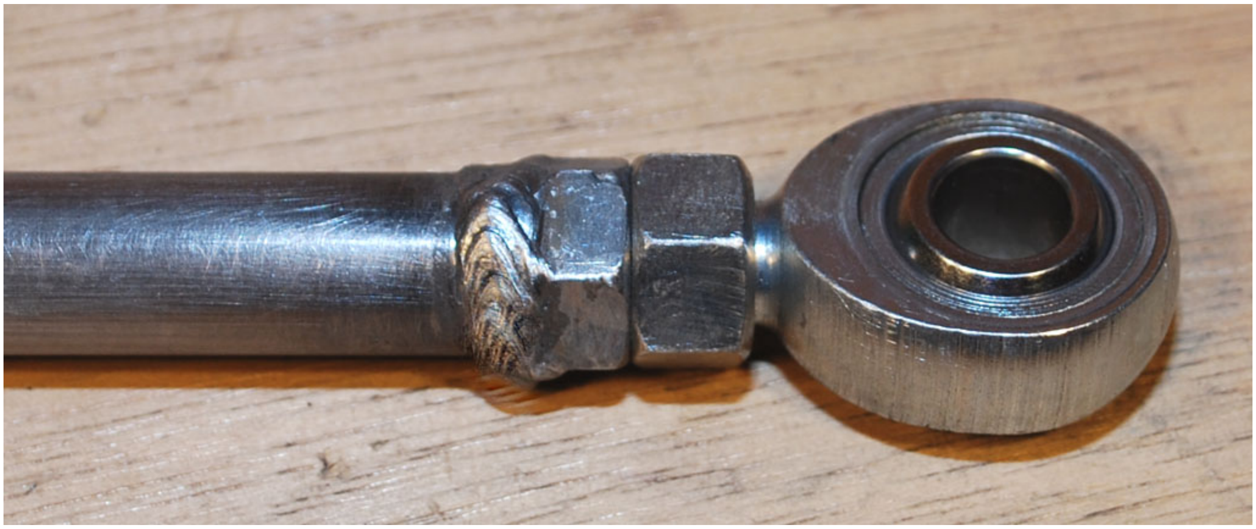


Figure 121 - The ball joint threads into the nut welded to the end of the rod

To set up the control rod so that it offers some fine tuning to make slight steering alignments, weld a nut to the end of the rod so that the ball joint body bolt can screw into the rod as shown in Figure 121. A second nut can then lock the position of the bolt so it will no longer turn. When welding the nut to the end of the rod, screw in a spare bolt to help center the nut and protect the threads from welding spatter. Do not have the ball joint in the nut when welding as the bearing may be damaged from the heat. Use a spare bolt of the same size.

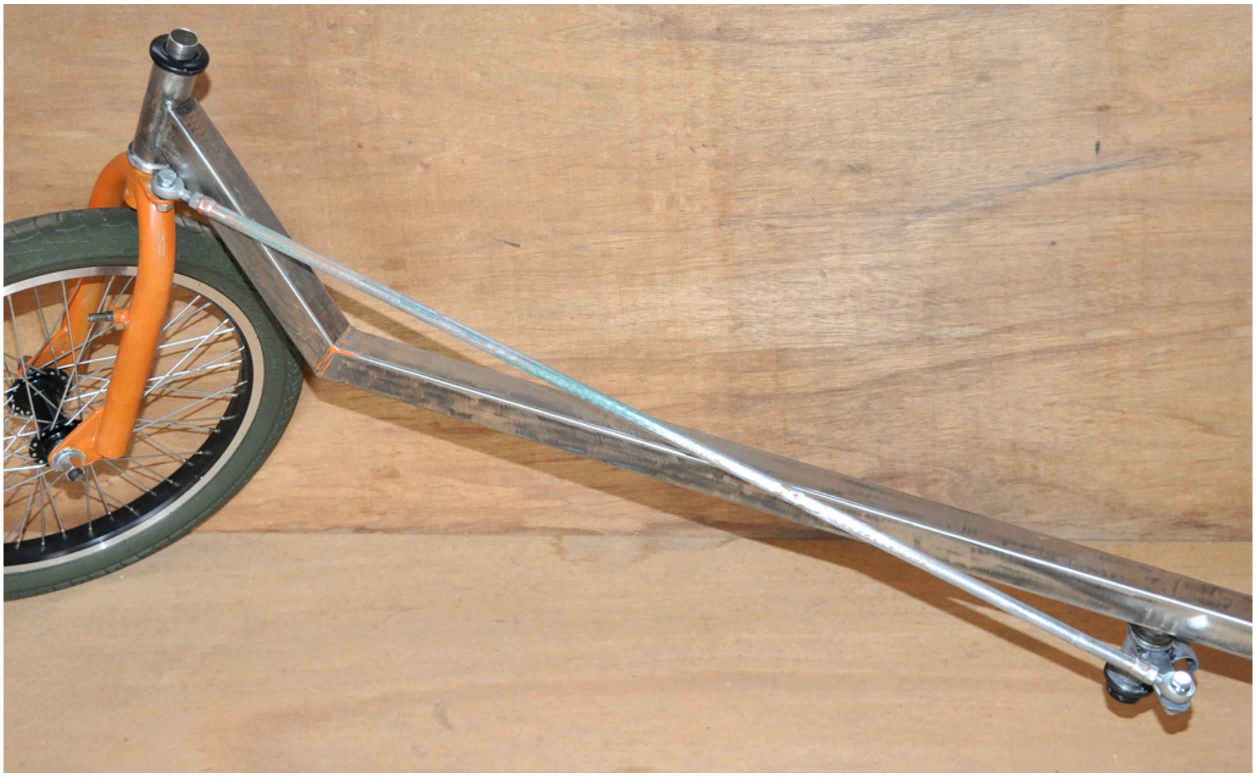


Figure 122 - Testing the range of steering rotation

Once you have installed the steering linkage, turn the handlebars back and forth to test the range of steering available. Forty-five degrees is plenty of rotation for the front wheel, and under normal riding conditions you will use a lot less than what is available her before lockout. You may also find that the steering can move to a sharper angle in the left direction because the control rod strikes the side of the frame during a sharp right hand turn. Figure 122 shows the steering system maxed out in the left turn rotation.

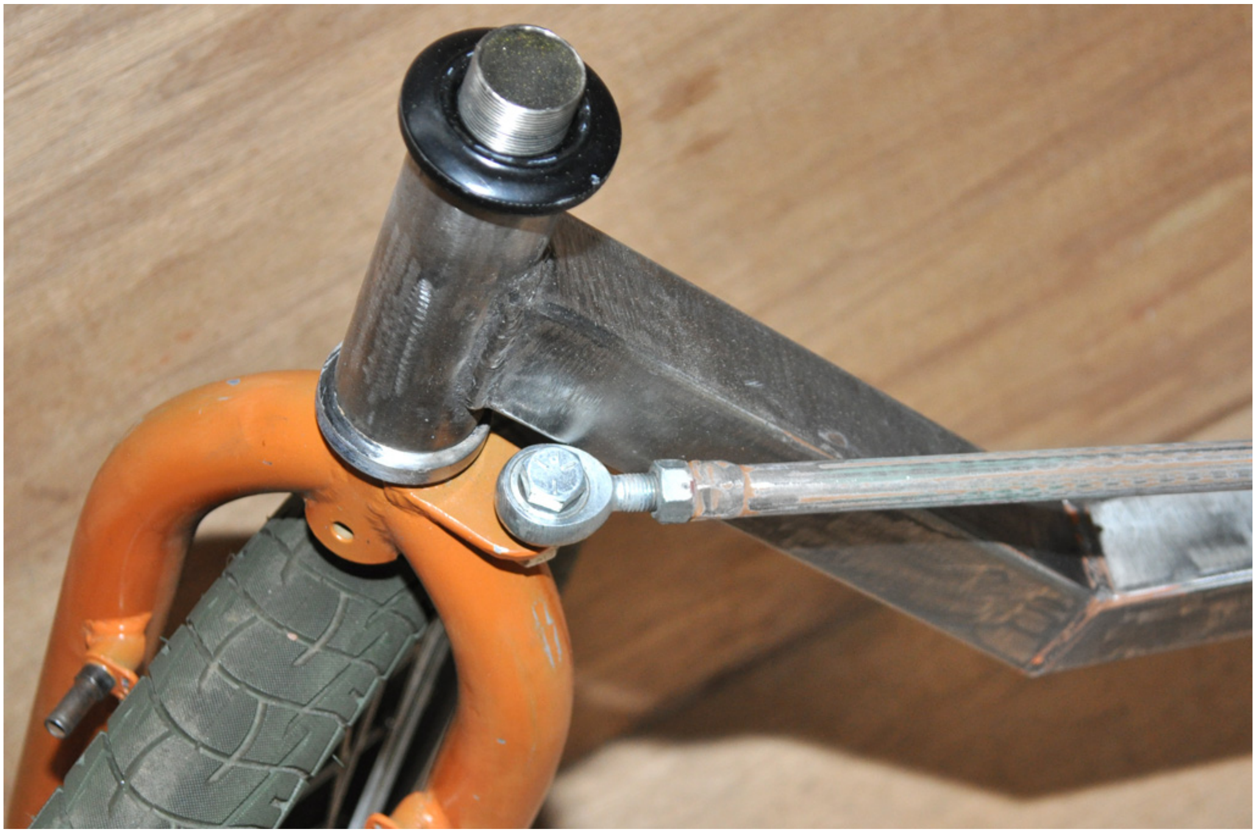


Figure 123 - Check the ball joints for clearance

Another thing to note is that you may require a little space between the top of the control arms and the ball joint body as there may be some rubbing as you turn. I have found this necessary when using the flat faced ball joints as shown in Figure 123, but this is an easy problem to solve. To make spacers that will lift the ball joints slightly, grind down a nut to about half of its thickness and then place it between the ball joint and the control arm. This creates enough space so that the body will no longer rub against the control arm in tight turns.

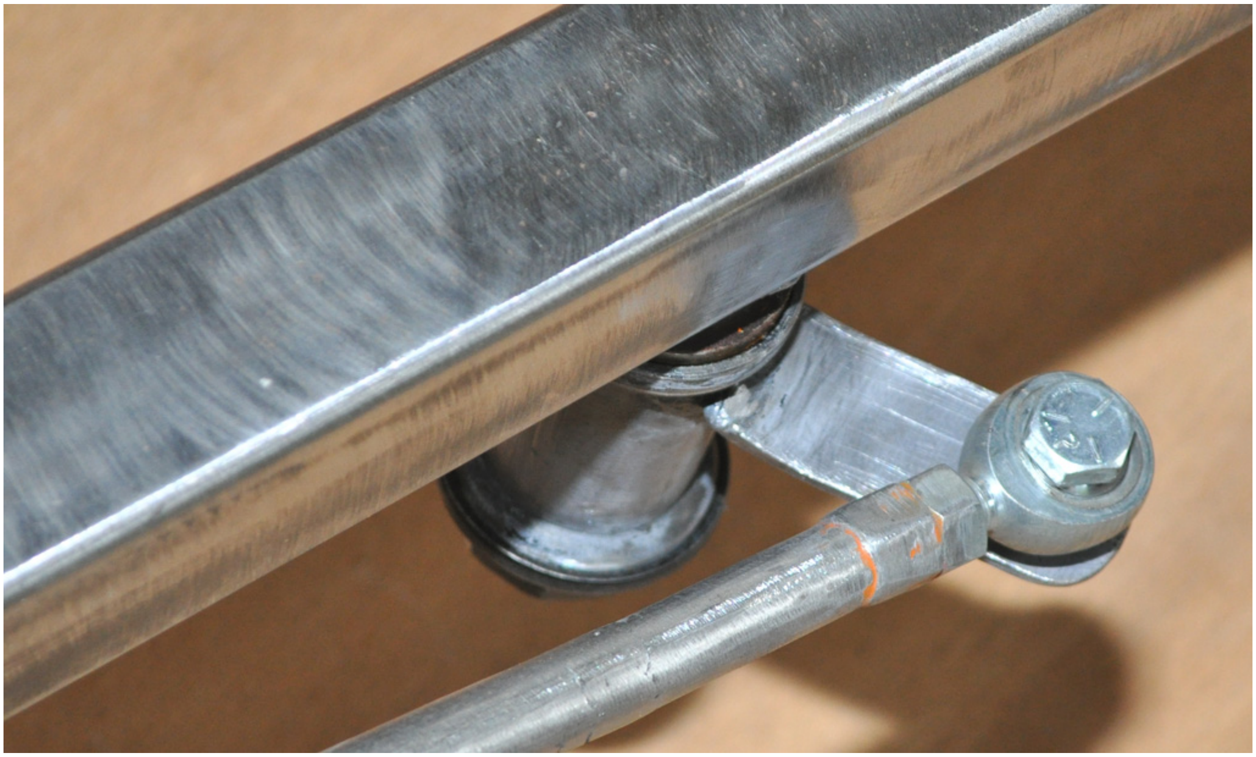


Figure 124 - Fine tuning of the control arms

If you still find excessive friction in the steering system after adding the spacers, then you may need to tweak the angle of the control arms slightly. To do this, use a large adjustable wrench to grip the end of the control arm and just bend it slightly to twist it into an angle that better follows the angle of the control rod. This should only be necessary if the ball joints have limited movement up and down.

BUILDING HANDLEBARS

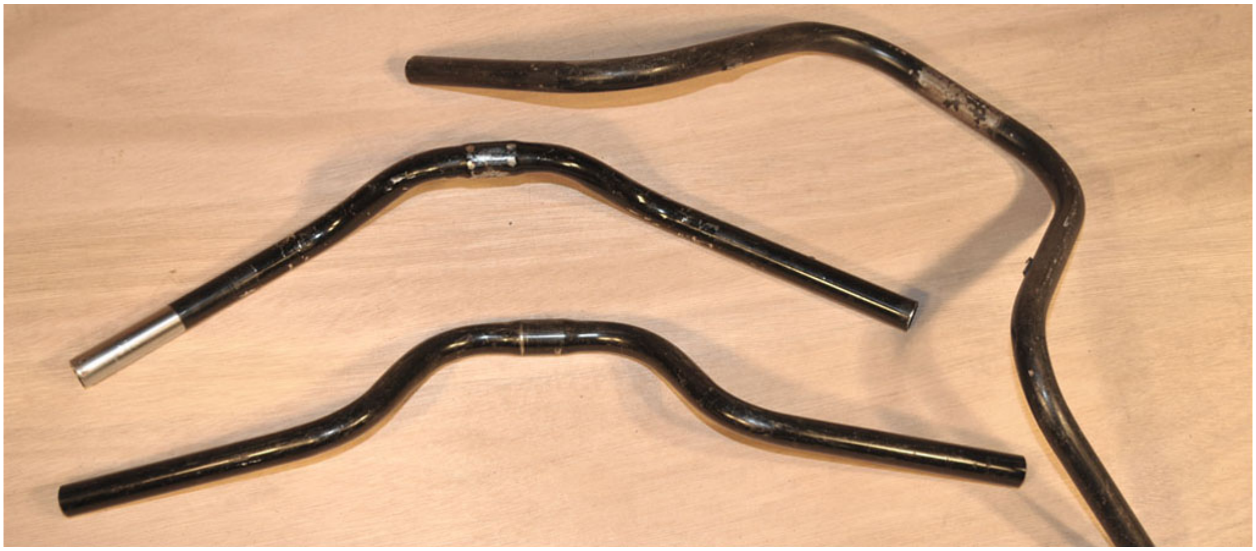


Figure 125 - Some possible handlebars for modification

Handlebars are one of those things that will vary from person to person, so you will need to experiment a little to find the shape and size of handlebar that will fit your style. You won't likely find a standard handlebar that will be a perfect fit for this trike, so you will need to cut and modify one to suit your needs. The huge "ape hanger" handlebar shown in the right side of Figure 125 almost worked as is, but it hit the bottom of the seat while turning, so modification was necessary. The other handlebars shown here are some of the ones I considered hacking up to extend the larger ones.

It is a good idea to skip ahead somewhat and first construct your seat, as this may affect the size and shape of the handlebars you will use. To decide how your handlebars will be shaped, sit on your seat with your feet on the pedals and place your hands in a grip position beside you where they feel most comfortable. I have seen production trikes that force the rider into a rigid long arm reach, but this is the last thing you want, so don't "cheat" and just drop on a straight handlebar or you will not end up with a very comfortable ride, especially on a long journey. Place your hands where you feel that they are most relaxed and then design your handlebars to meet you, not the other way around.

✓ Builders Tip

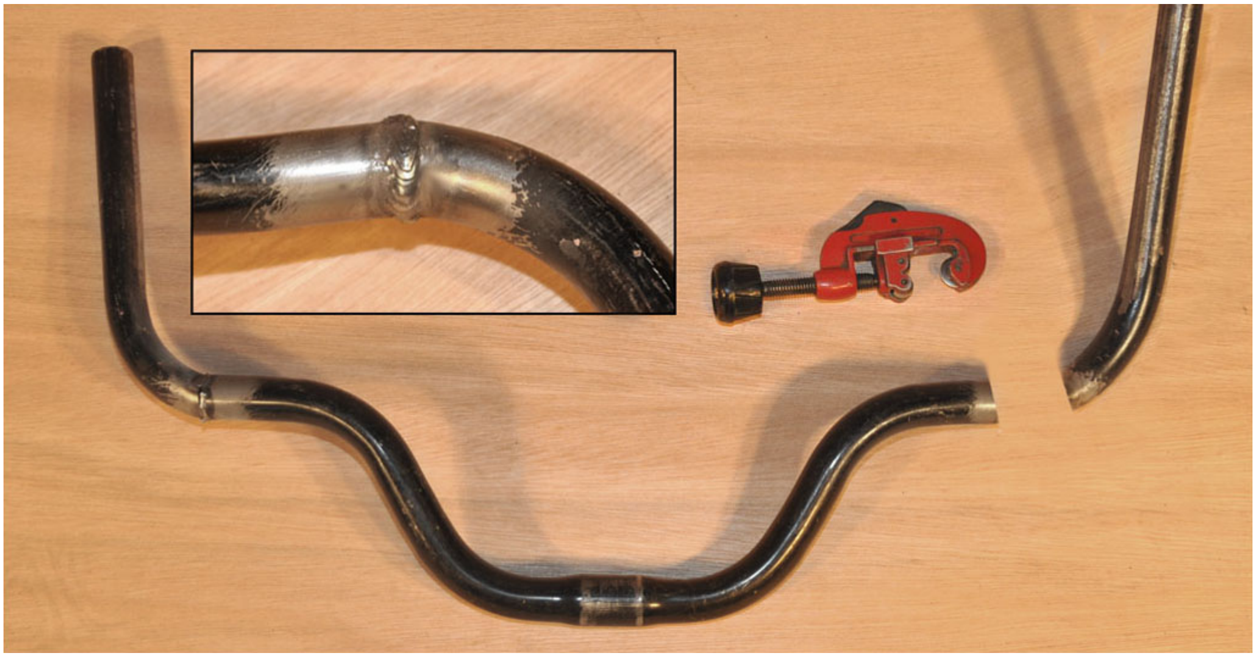


Figure 126 - Cutting and joining the handlebars for optimal fit

With a tube cutter and a welder, you can create any size and shape of handlebar possible, so once you have found your optimal grip position, work your way up by starting with a standard mountain bike handlebar like the one being used in Figure 126. You can add any similar size and thickness tubing into the mix as long as the center part that connects to the stem is left intact and the handle grip ends are also standard handlebar tubing. I simply cut up two sets of handlebars and joined them as shown in Figure 126, making a system that felt comfortable and did not hit the seat when turning. Again, you will definitely need to experiment here.

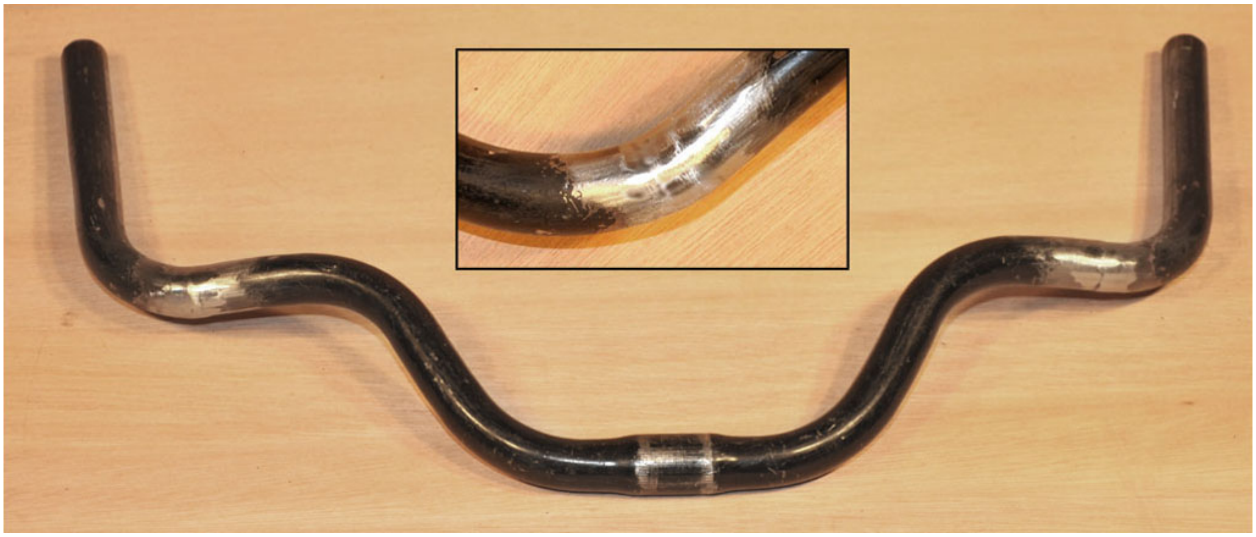


Figure 127 - The completed trike compatible handlebars

When welding handlebar tubing back together, ensure that your welds are done properly and only grind as much as you need in order to get the shifting hardware over the area. A little hill is always better than a valley when you are cleaning up welds. Figure 127 shows the handlebars I made that placed my hands just to the side at the slight wrist angle that seemed most natural.

MAKING A SEAT

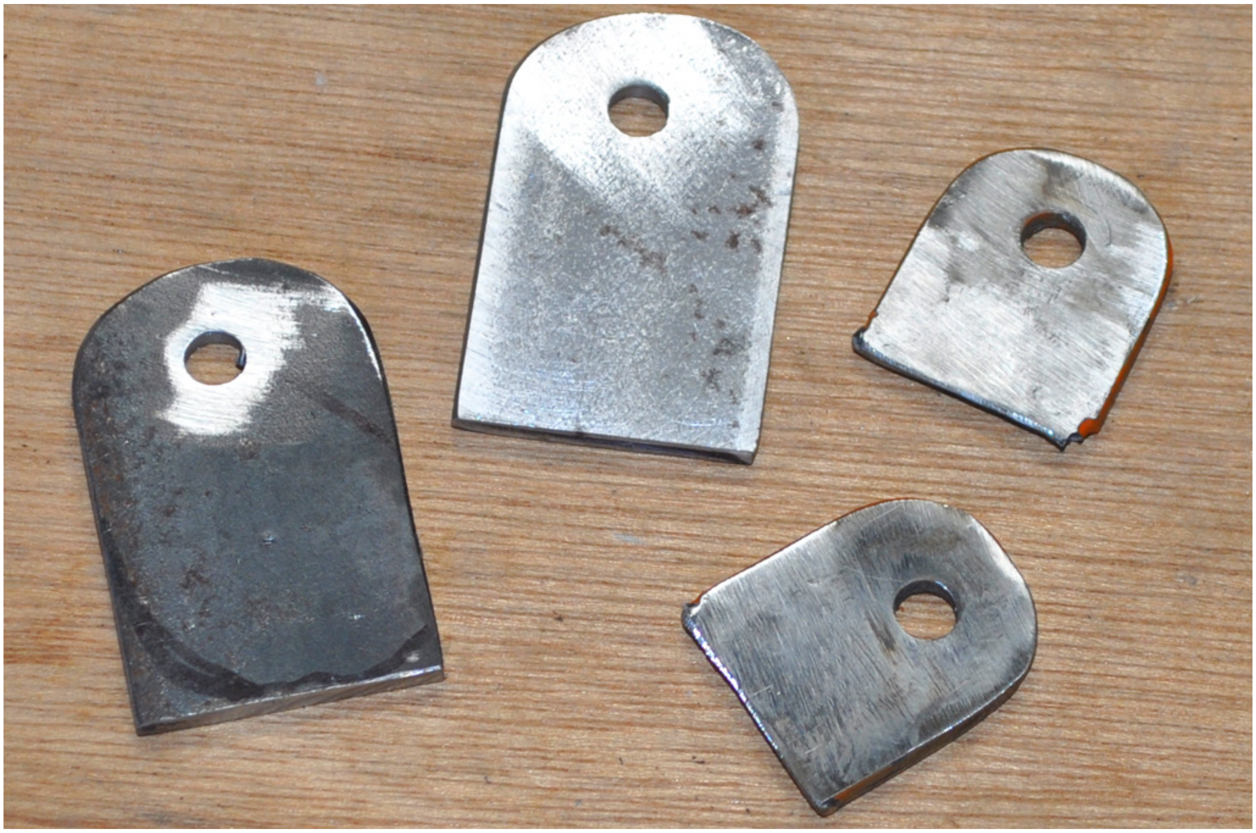


Figure 128 – The seat mounting tabs

The plywood seat will be fastened to the rear seat tube and main boom using a set of 2 inch tabs as shown in Figure 128. These are placed so that they are about half way on each seat board. The tabs are then drilled for a pair of woodscrews. 1/8 inch thick flatbar with a width of 1 inch or 1.5 inches is just fine. I made my seat base mounting tabs a little wider than the other ones because that was the material I had lying around the shop.

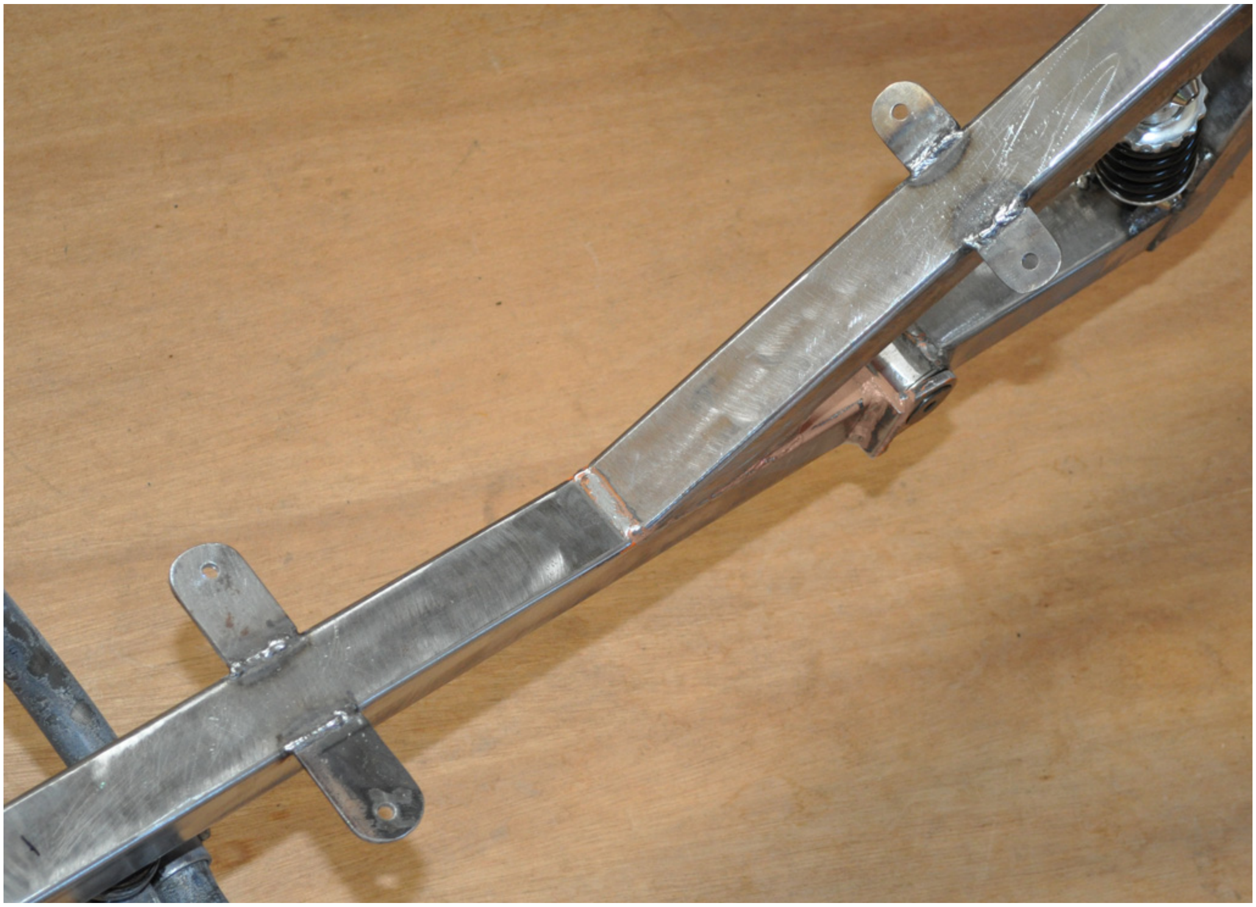


Figure 129 - Welding the seat tabs to the frame

The seat base tabs are welded to the boom about half way between the corner joint of the seat back tube and the fork stem as shown in Figure 129. The seat back mounting tabs are welded to the seat back tube at about the half way mark. Weld both sides of the joint.

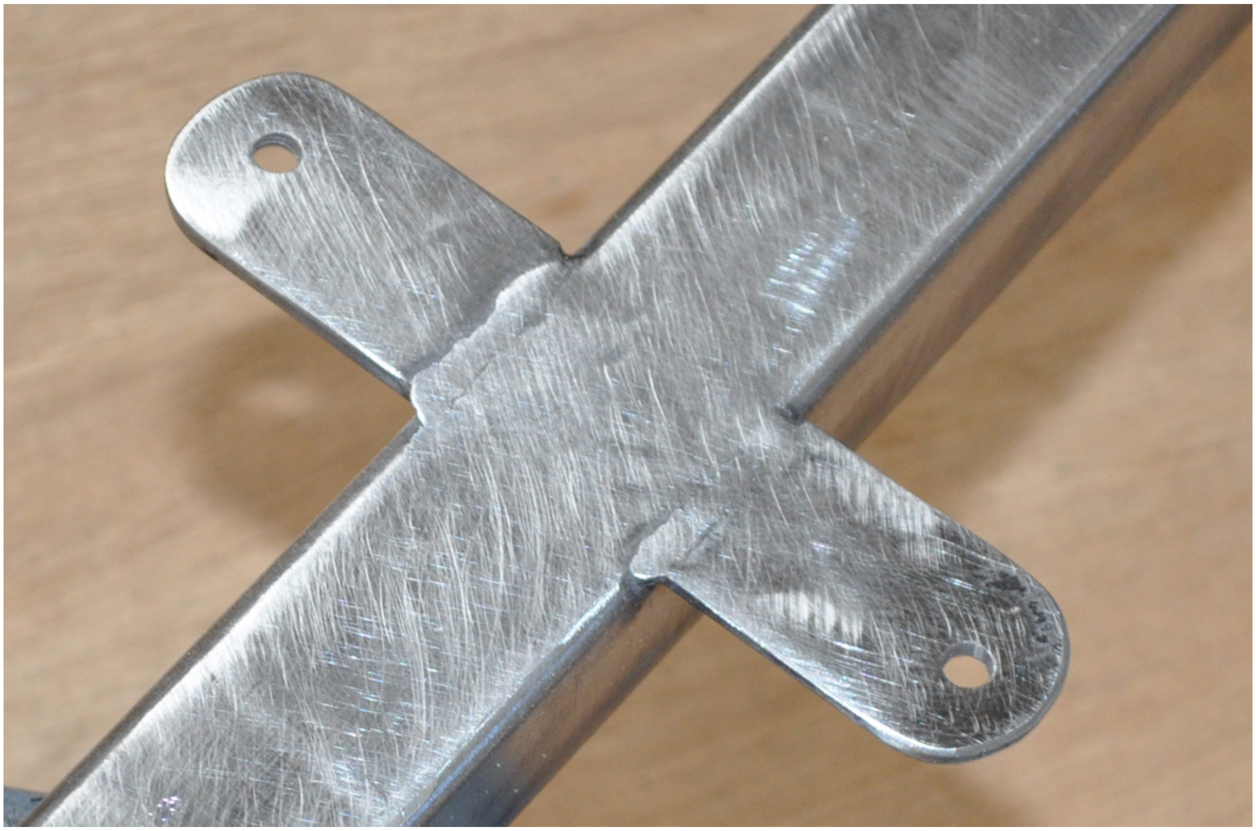


Figure 130 - Grind the top of the joint flush

Once you have welded both sides of the joint on all four seat mounting tabs, use a sanding disc to grind the top welded area flush with the frame as shown in Figure 130. This is necessary so that the seat boards sit flat on the frame.

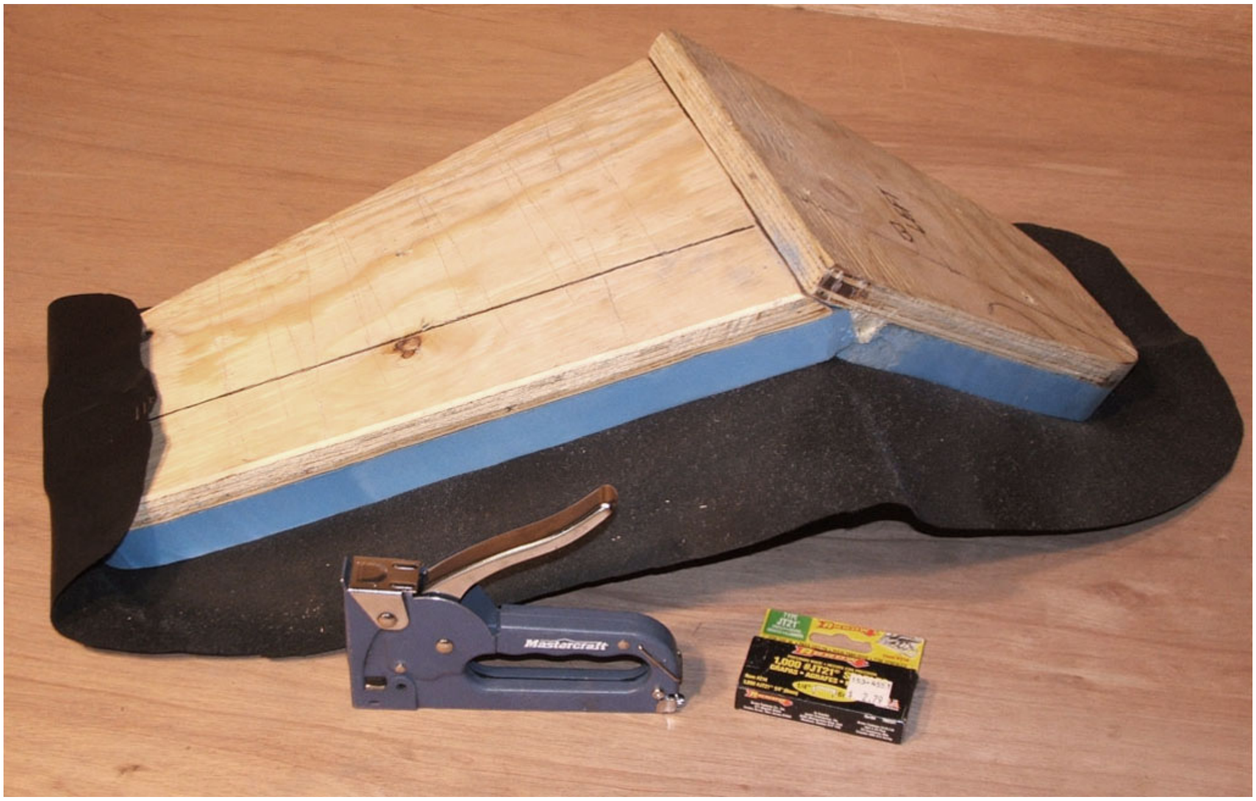


Figure 131 - Creating a simple wood and foam seat

The seat shown being made in Figure 131 is made by bolting two half inch thick plywood boards together at the center using a pair of shelf brackets. One inch or slightly thicker dense foam is then glued to the wood and trimmed around the edge using a knife or the angle grinder. The seat is covered with either spandex or some kind of vinyl to make it resist moisture and wear. The seat can be made to whatever width you like, but remember that the under seat steering handlebars have to find their way around the base of the seat.

I usually use the same basic seat dimensions, which are as follows: the bottom is 10 inches square, tapered to 6 inches at the front and the back is 15 inches tall, tapered from 10 inches to 6 inches as well to match the bottom. A separate back rest is then made (shown later) as it is easier to make small comfort adjustments this way. These measurements are shown in Figure 137.

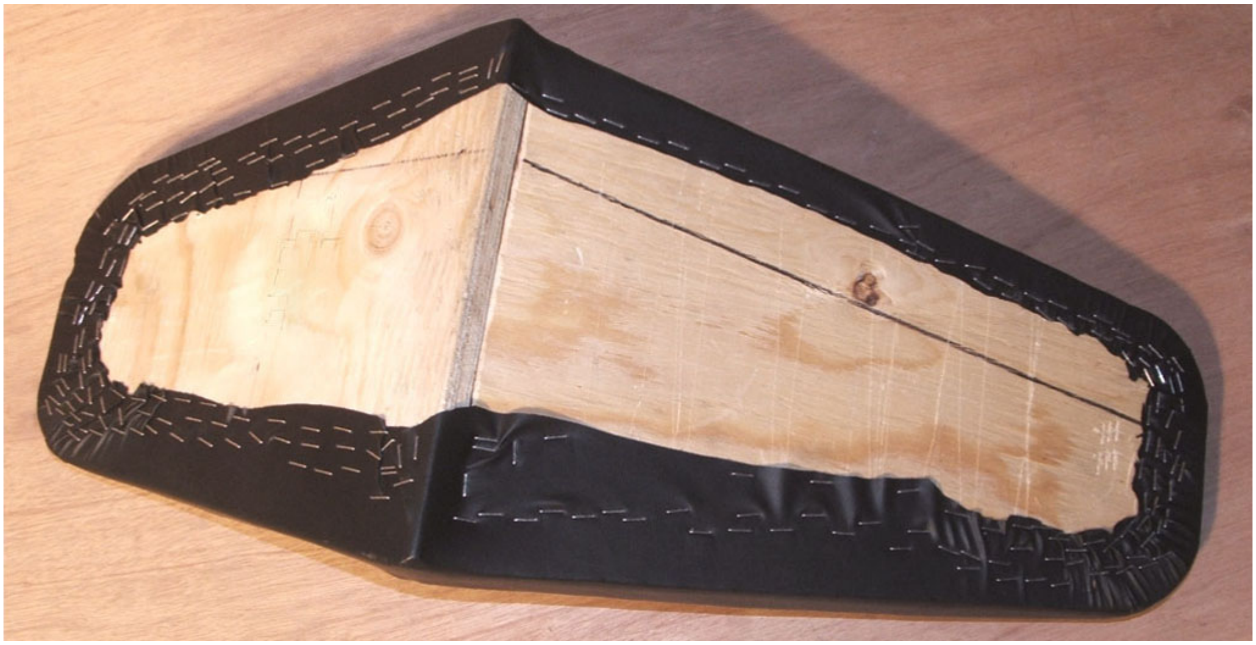


Figure 132 - Staple the seat material to the back of the wood

To make a covered seat with as few wrinkles as possible, start at one end and then keep stretching and stapling material as you work around the seat. You will not be able to get all of the wrinkles out like this, but you can get fairly close and end up with a very nice looking seat that doesn't cost you a fortune. Sometimes when stapling around the material, it helps to lift up some of the staples if a wrinkle seems large in that area. Figure 132 shows the result of about 20 minutes of material stretching and stapling.

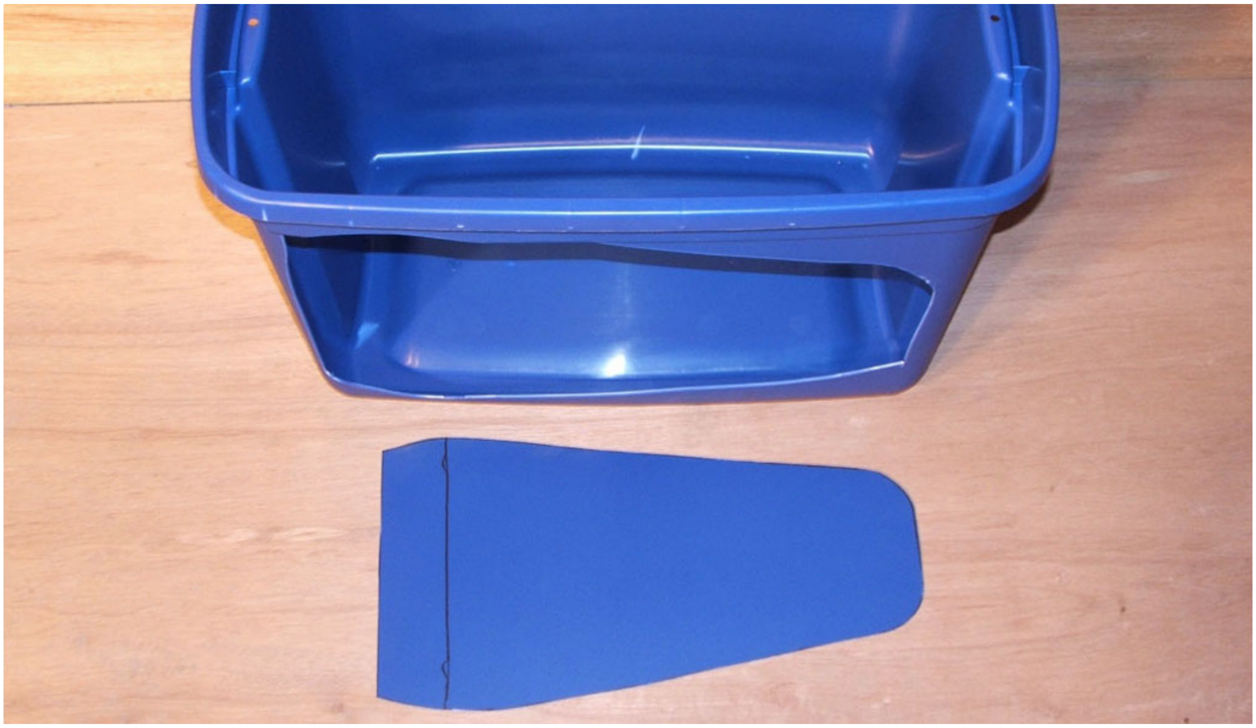


Figure 133 - Staple the seat material to the back of the wood

To cover up the visible rear portion of the seat where all of those staples live, a cover can be made by cutting out the required shape from a plastic bucket as shown in Figure 133. Upholstery tacks can be used to fasten the cover to the wood back.

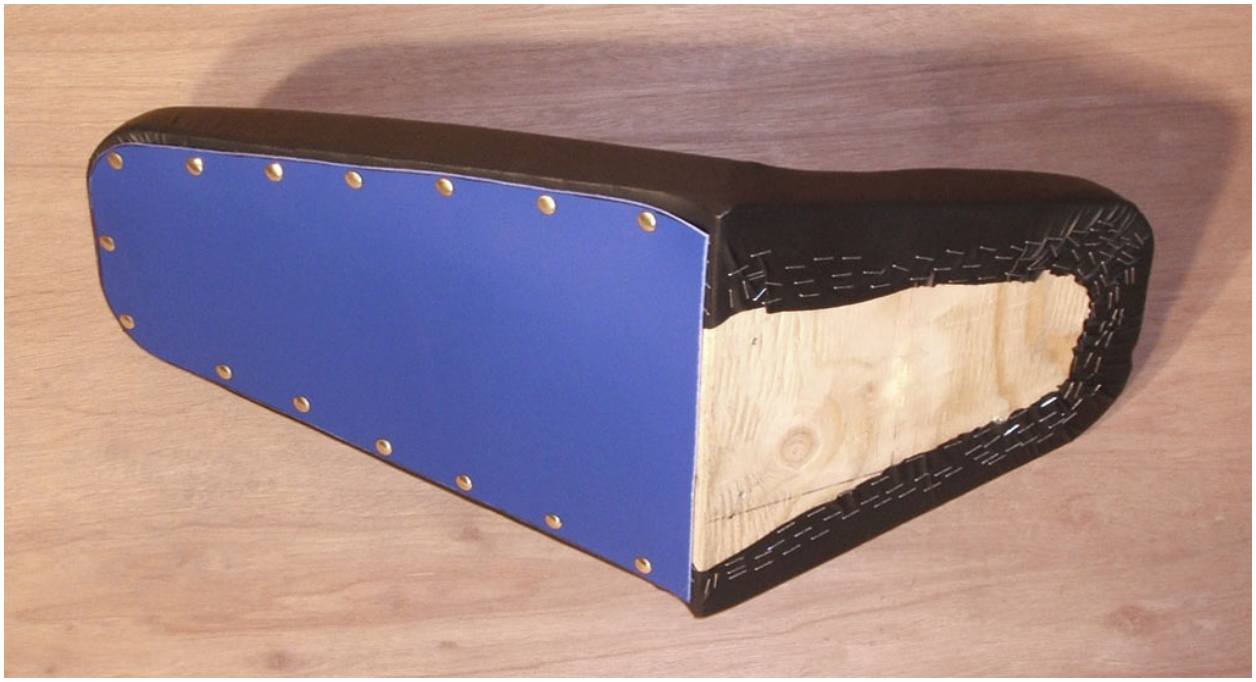


Figure 134 - Installing the rear cover that will hide the ugly staples

Figure 134 shows how the plastic backing is installed over the stapled area, using several thumb tacks to fasten it to the wood. The completed seat will look close to factory made once installed, which is not bad considering it cost only a few dollars to create.

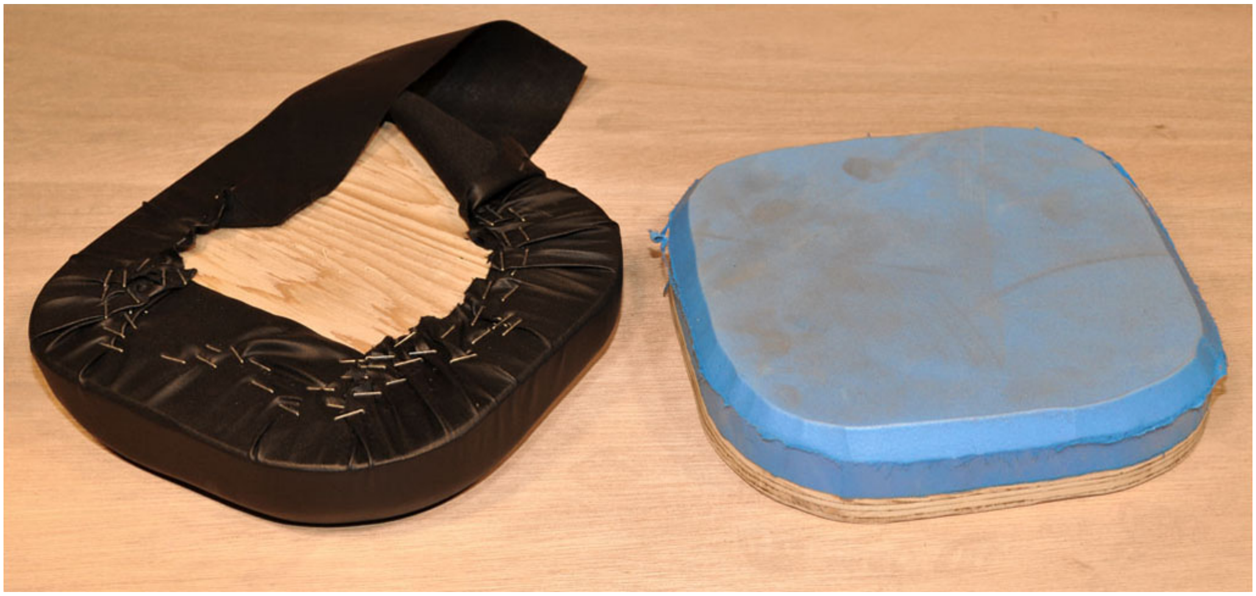


Figure 135 - Making a back rest using the same techniques

For maximum comfort, an upper back rest will also be added to the seat, and this 8 inch square part is made using the same wood, foam, and material as the rest of the seat. Since it’s visible from behind, the rear of the back rest will also get a plastic cover to hide the stapled area. Feel free to alter your seat design to suit your needs. Note: a head rest is not a good idea on a recumbent bike as you won't be able to look behind and all of the bumps from the road will be transferred directly to your head.

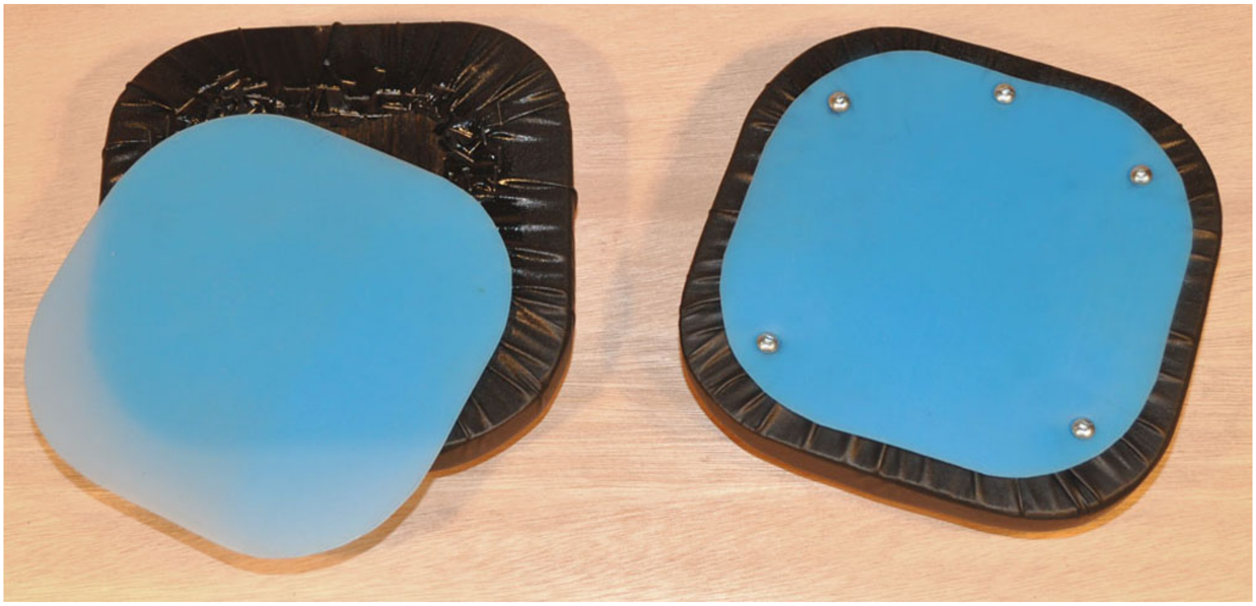


Figure 136 - Adding the decorative cover to the back rest

If you find that the plastic is slightly translucent and not completely hiding the staples and wood, paint the area black as shown in Figure 136 and then the cover will completely hide all of the rough area underneath.

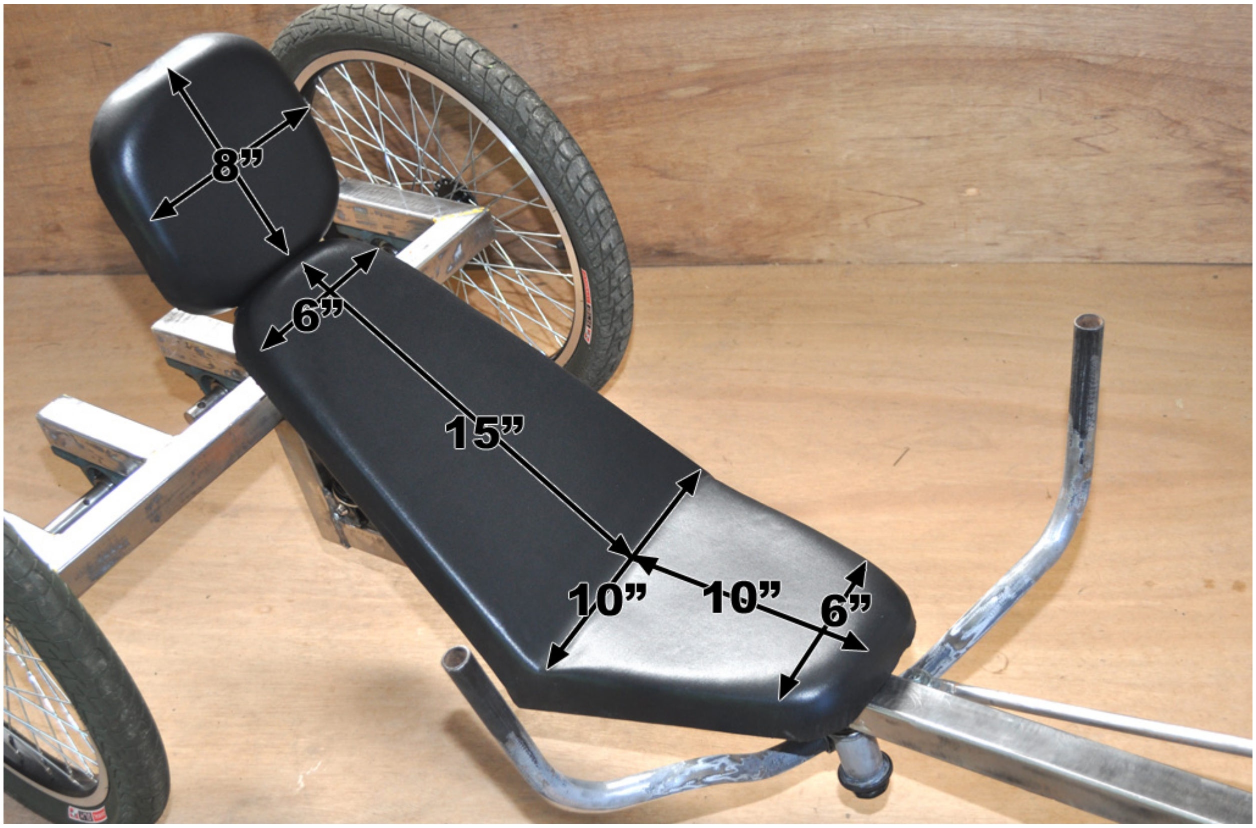


Figure 137 - Seat dimensions shown

Figure 137 shows the dimensions I used for my seat. I find these measurements make a very comfortable seat that works well on just about any kind of recumbent trike or bike, but don't be afraid to experiment and try out your own seat designs.

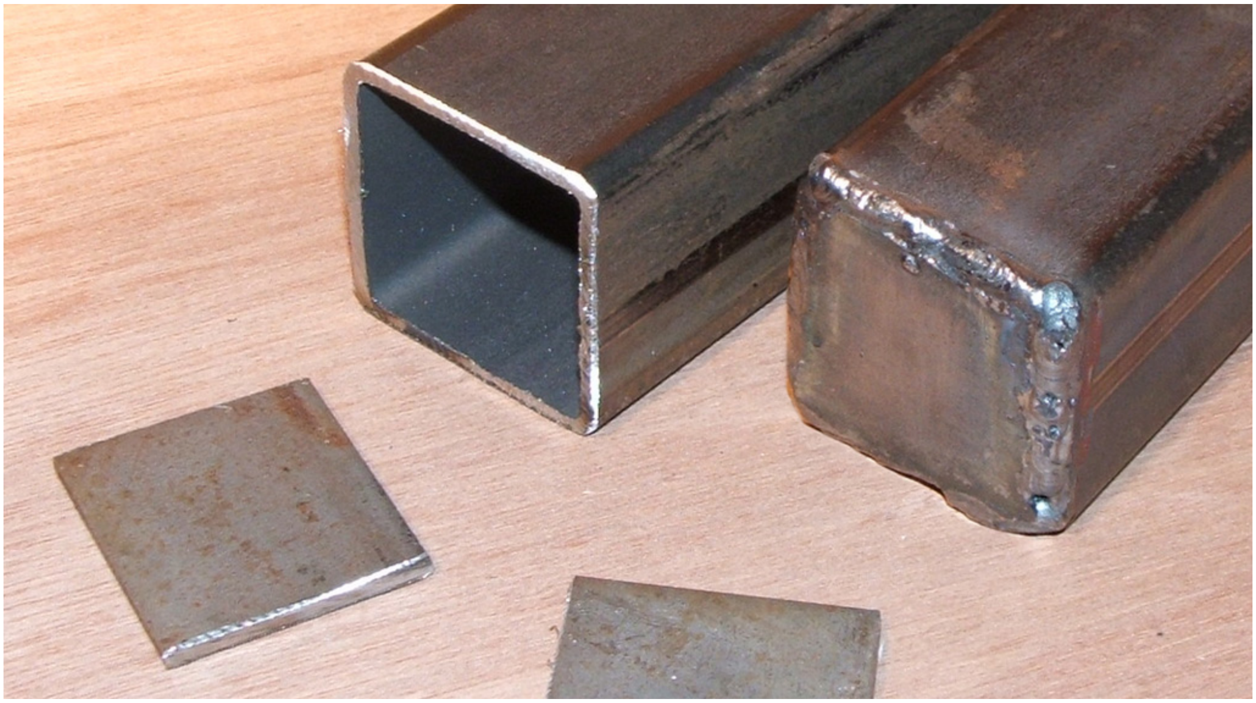


Figure 138 - Adding a top cap to the open end of the seat tube

The back rest portion of the seat will sit at a much steeper angle than the back of the seat and will be installed over the top of the seat back tube. For this reason, a cap must be made for the open end of the seat back tube. This cap is made by cutting a 1.5 inch square piece from some scrap tubing so it can be welded to the end of the seat back tube as shown in Figure 138. The left image shows the tube before adding the cap and the right image shows the cap after rough welding it all the way around the joint.

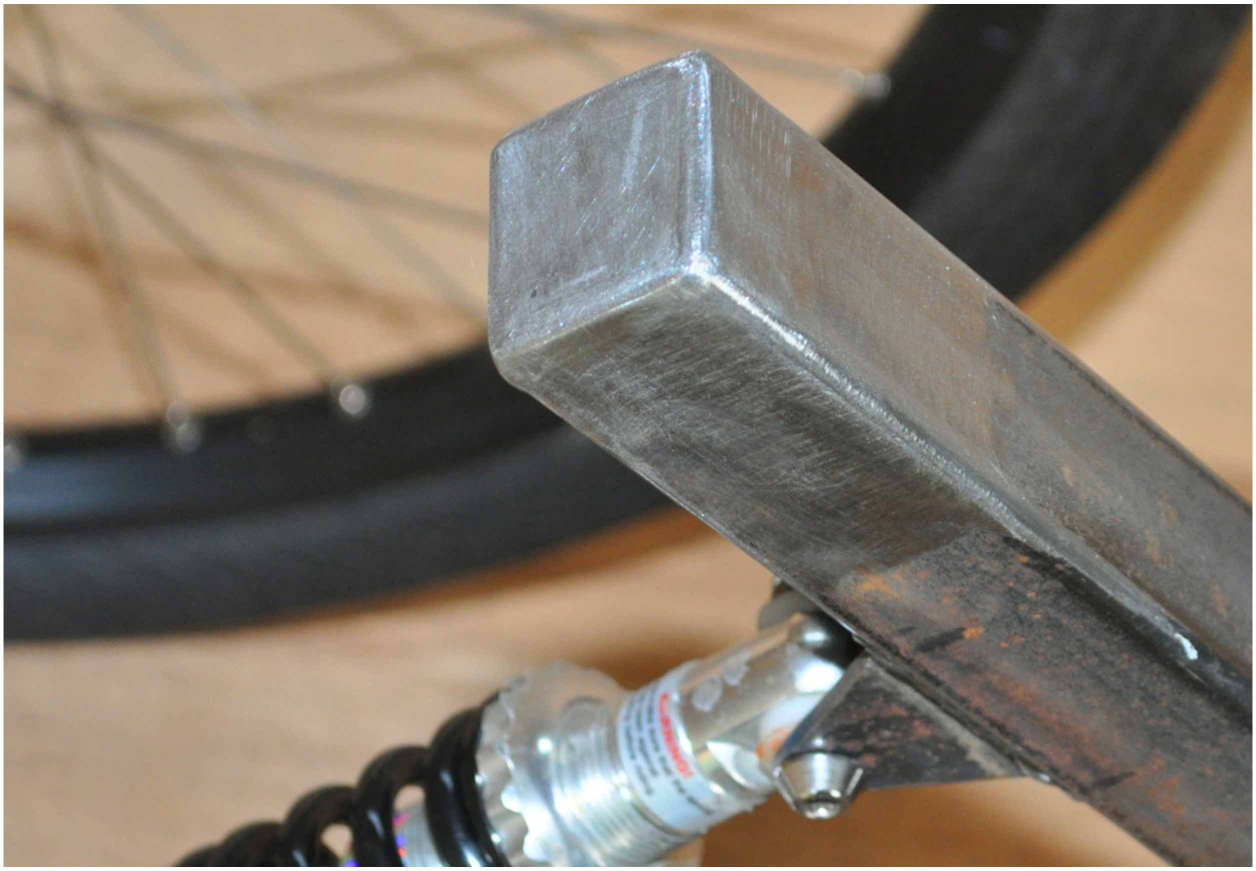


Figure 139 - After cleaning up the welds with a sanding disc

The top of this tube is one of those areas that will be visible to those looking at your trike, so it is worth the extra effort when cleaning up the welds. Figure 139 shows the results of grinding with the sanding disc to remove any of the welding seams.

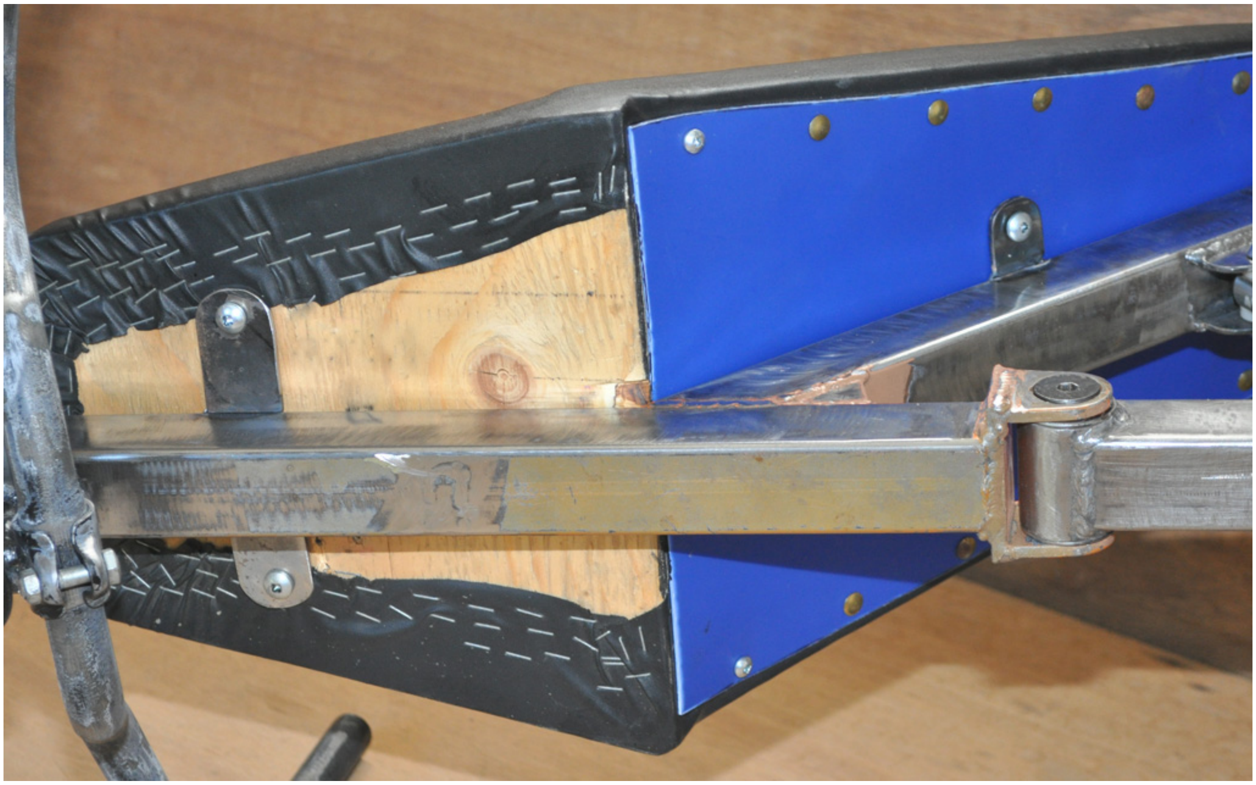


Figure 140 - Fastening the seat to the frame

To complete the back rest part of your seat, you will need to be sitting in the seat to determine the optimal angle for your own comfort. Fasten the seat to the frame by using woodscrews through the seat mounting tabs as shown in Figure 140. Remember to use woodscrews that are no longer than the thickness of your plywood or they will be entering your seat padding.

✓ Builders Tip

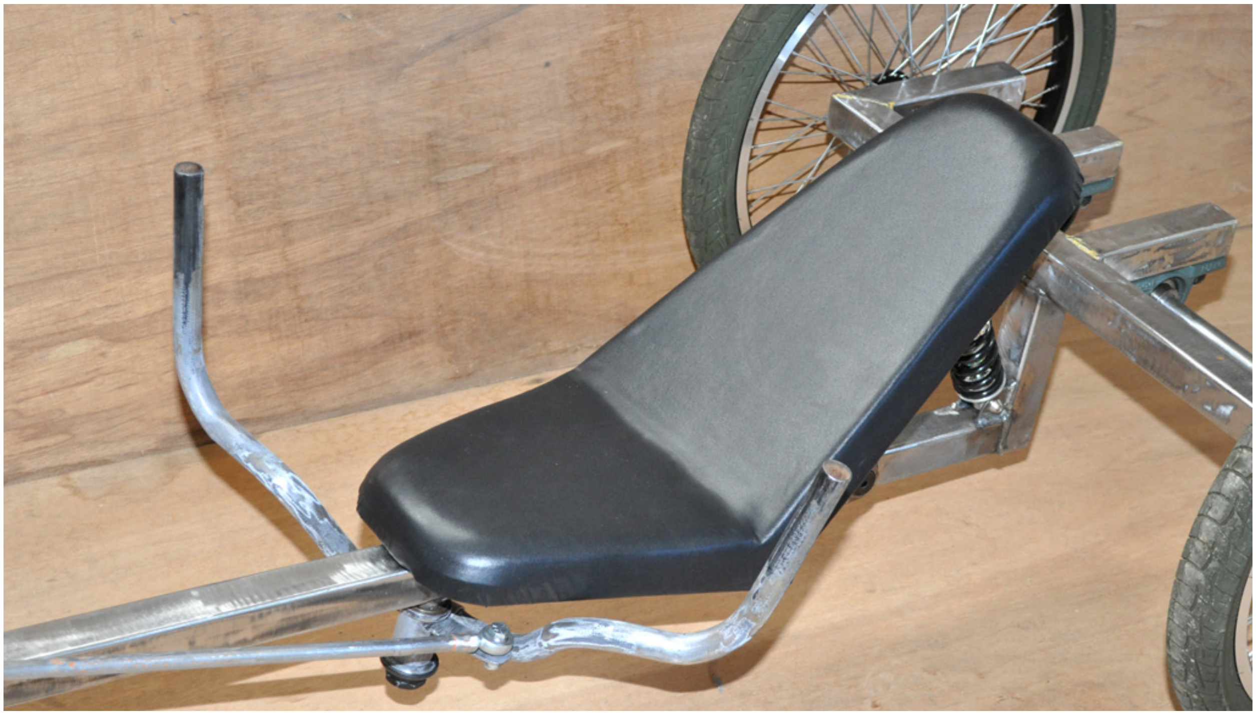


Figure 141 - Setup the seat and handlebars

It's also a good idea to have your handlebars installed when working out the best angle for the seat back rest so you can hold onto the handlebars and sit in your relaxed riding position. Figure 141 shows the comfort position of my handlebars, which placed my hands at a relaxed position beside the seat.

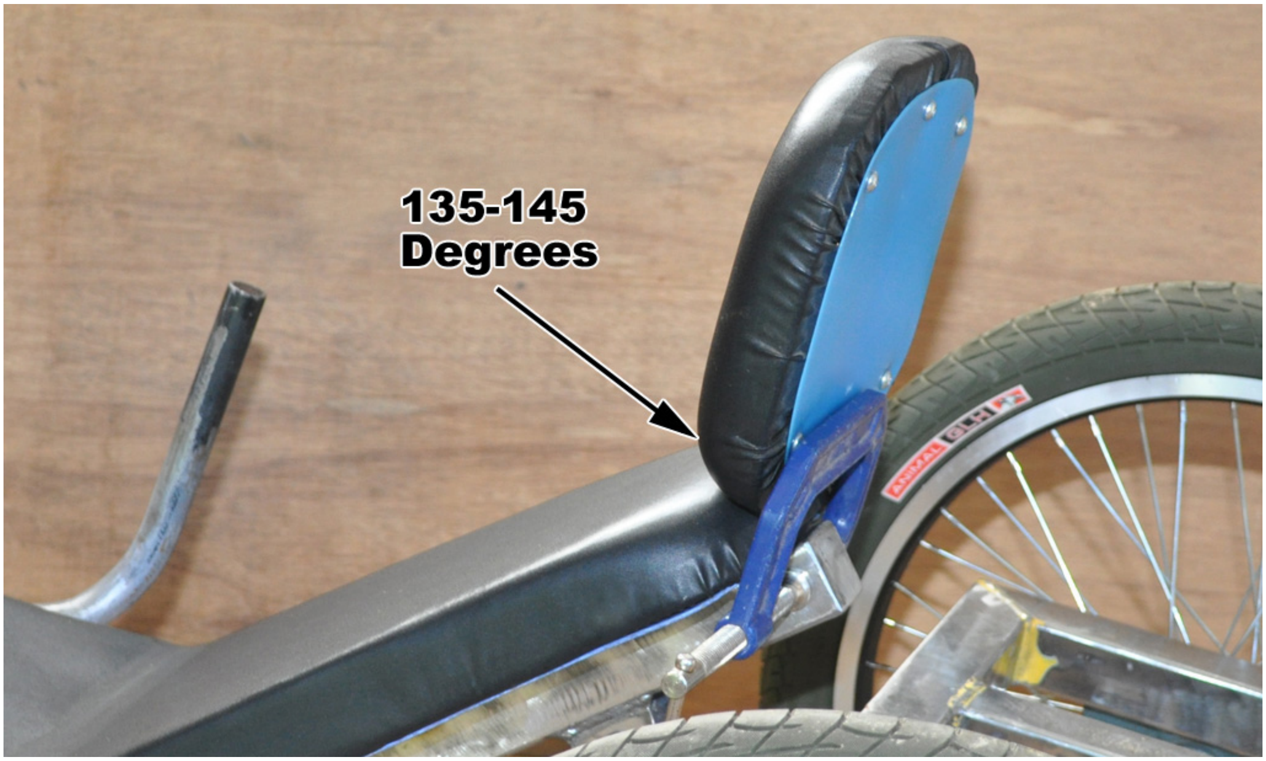


Figure 142 - Finding the optimal back rest position

The angle of the back rest portion of the seat is completely up to you, and should be found by sitting in the seat while a helper holds the back rest firmly in place. You can also use a clamp to hold the seat back up while you try various angle to find one that you find most comfortable. As shown in Figure 142, I found the angle of 138 degrees to feel just right.

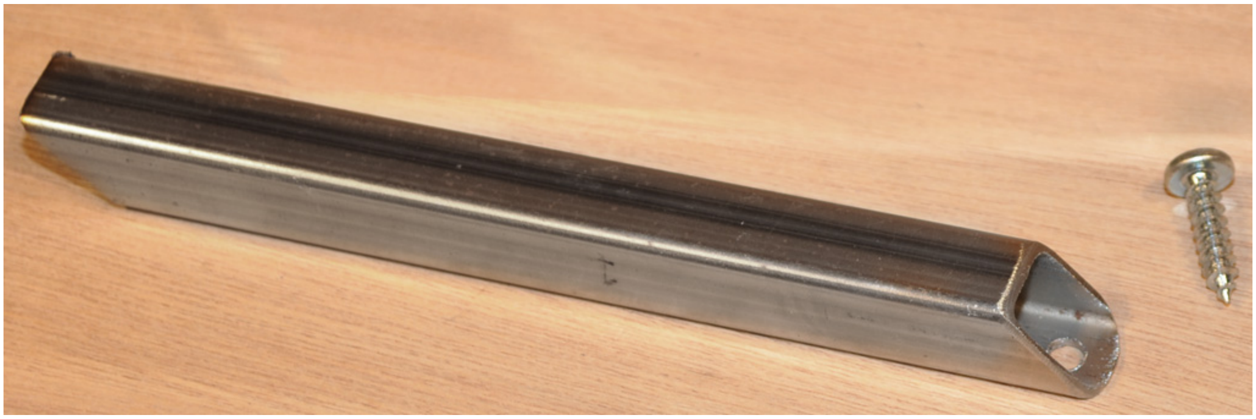


Figure 143 - The back rest support tube

The back rest support tube is a short length of ¾ inch wide square tubing that is welded directly to the cap on the end of the seat back tube as shown in Figure 144. The end has been cut at 45 degrees so a woodscrew can be used to fasten the back rest in place. There is another hole drilled through the midpoint of the tube for a second woodscrew.

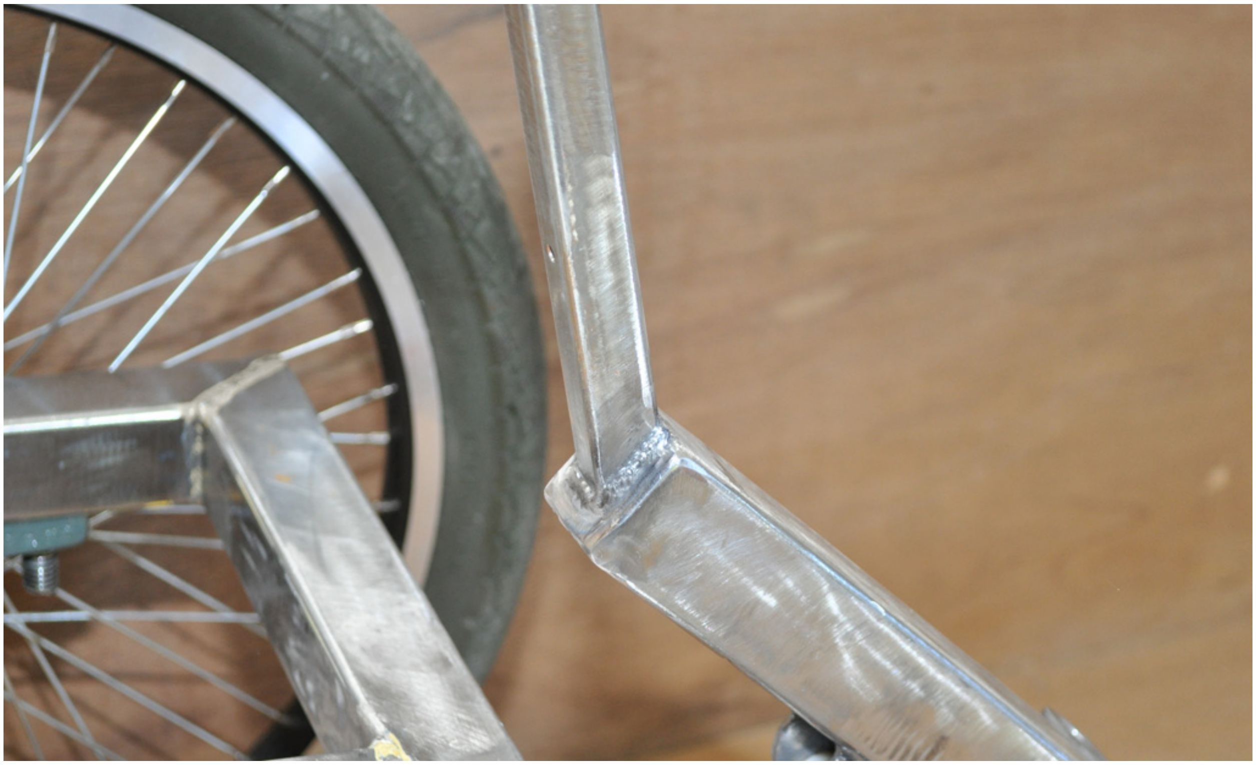


Figure 144 - Welding the back rest tube

Once you have worked out the best angle for your back rest, use an adjustable square to record the angle so you can install the 3/4 inch back rest support tube onto the top cap as shown in Figure 144. Tack weld the front and rear of the joint and then drop your seat back onto the frame for one last check before welding around the entire joint.

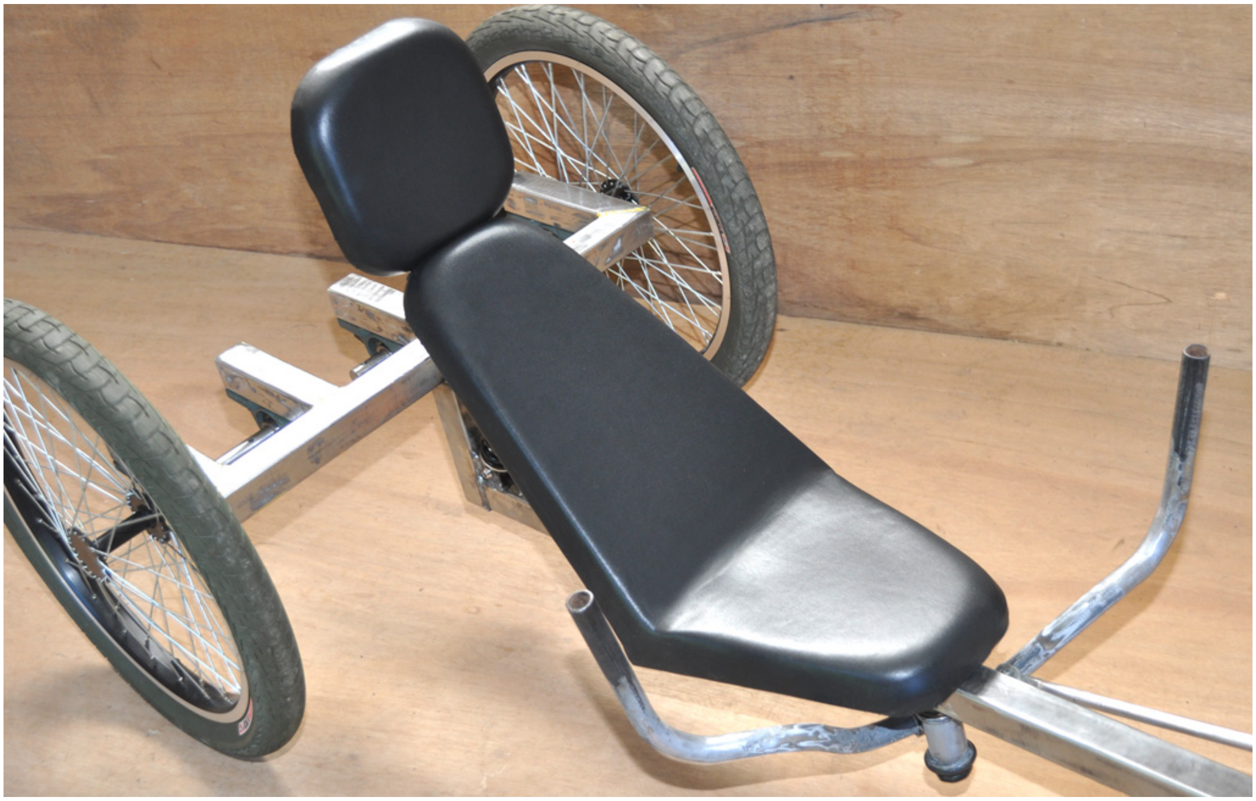


Figure 145 - The completed seat

Figure 145 shows the completed Aurora Trike seat including the back rest. Feel free to experiment with different seat types and angles that best suit your needs. However, be mindful of the underseat steering clearance.

ADJUSTABLE BOTTOM BRACKET

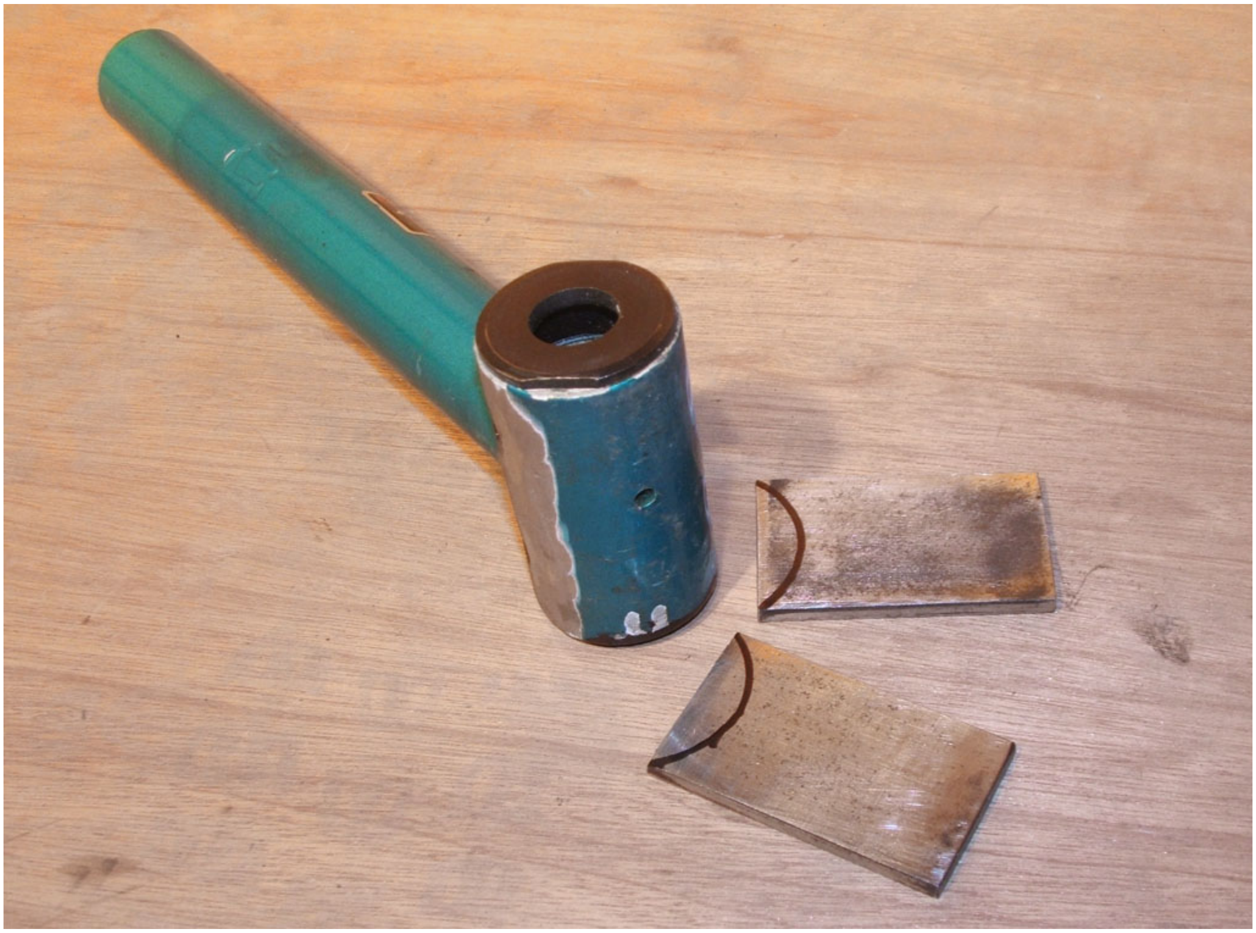
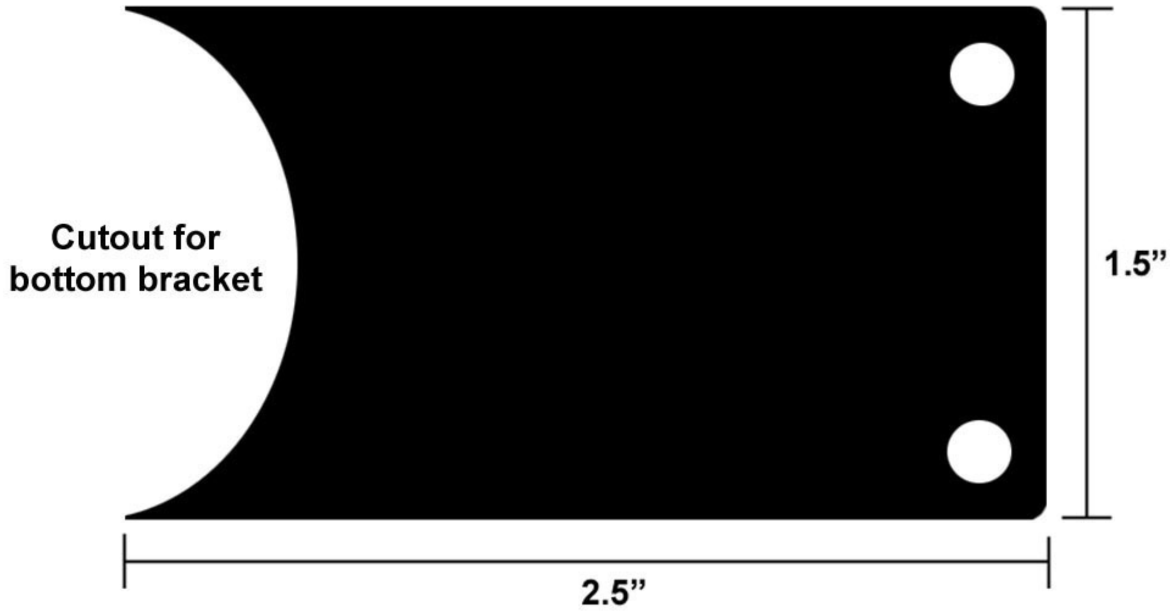


Figure 146 - Making an adjustable bottom bracket

The Aurora Trike includes an adjustable bottom bracket so that riders of varying leg lengths can adjust the distance between the seat and pedals for optimum comfort and performance. Moving the bottom bracket is more practical than moving the seat because the steering system would also have to move with the seat, creating a very complex and difficult design to adjust linkage system. By moving the bottom bracket, we only have to deal with the front derailleur, which just happens to be part of the sliding bottom bracket, so adjustments can be made easily. Any difference in chain length can be taken up by the rear derailleur's spring mechanism, so the entire process is painless and easy.

Since the front derailleur requires a length of the seat tube to hold the clamp in place (as it did on the original bicycle frame), we will leave a bit of this tubing when we cut away the bottom bracket from the scrap bicycle frame as shown in Figure 146. Cut the chain stays and down tube from the bottom bracket and leave at least 12 inches of the seat tube intact, so you will have plenty of room to place the derailleur no matter what type of front chain ring you plan to install. The extra length of seat tubing will be cut away once you have the front derailleur in place.

The bottom bracket and included seat tube will be mounted to the main boom with a clamp arrangement that allows the assembly to be placed practically anywhere on the boom to allow riders of varying heights to ride the bike. The two plates shown in Figure 146 will form the sides of the clamp that will hold the bottom bracket against the side walls of the main boom as they are forced together by two bolts.



Drawing 5 - Adjustable bottom bracket clamps

The bottom bracket and front derailleur tube move together along the main boom, so you do not need to worry about the position of the derailleur over the chain ring. The chain is cut to the perfect length once the bottom bracket has been adjusted for the main rider, but will still allow a few inches of adjustment in either direction without a chain alteration due to the spring loaded rear derailleur. Of course, the difference between a 6 foot 5 inch adult versus a 4 foot tall child will likely require some chain adjustment, but this can be changed in minutes with an inexpensive chain link tool.

Cut two 3/16 inch thick pieces of plate or sheet to make the shapes as shown in Drawing 5. The round area is cut to conform to whatever size bottom bracket you decide to go with, and the two bolt holes will be drilled for 1/4 inch bolts. The bolt holes are drilled at the edge of the plates so that there is 1/8 inch of material between the hole and edge of the plate. These two plates will form a "vice" that will clamp the bottom bracket to whatever position on the main boom you want.

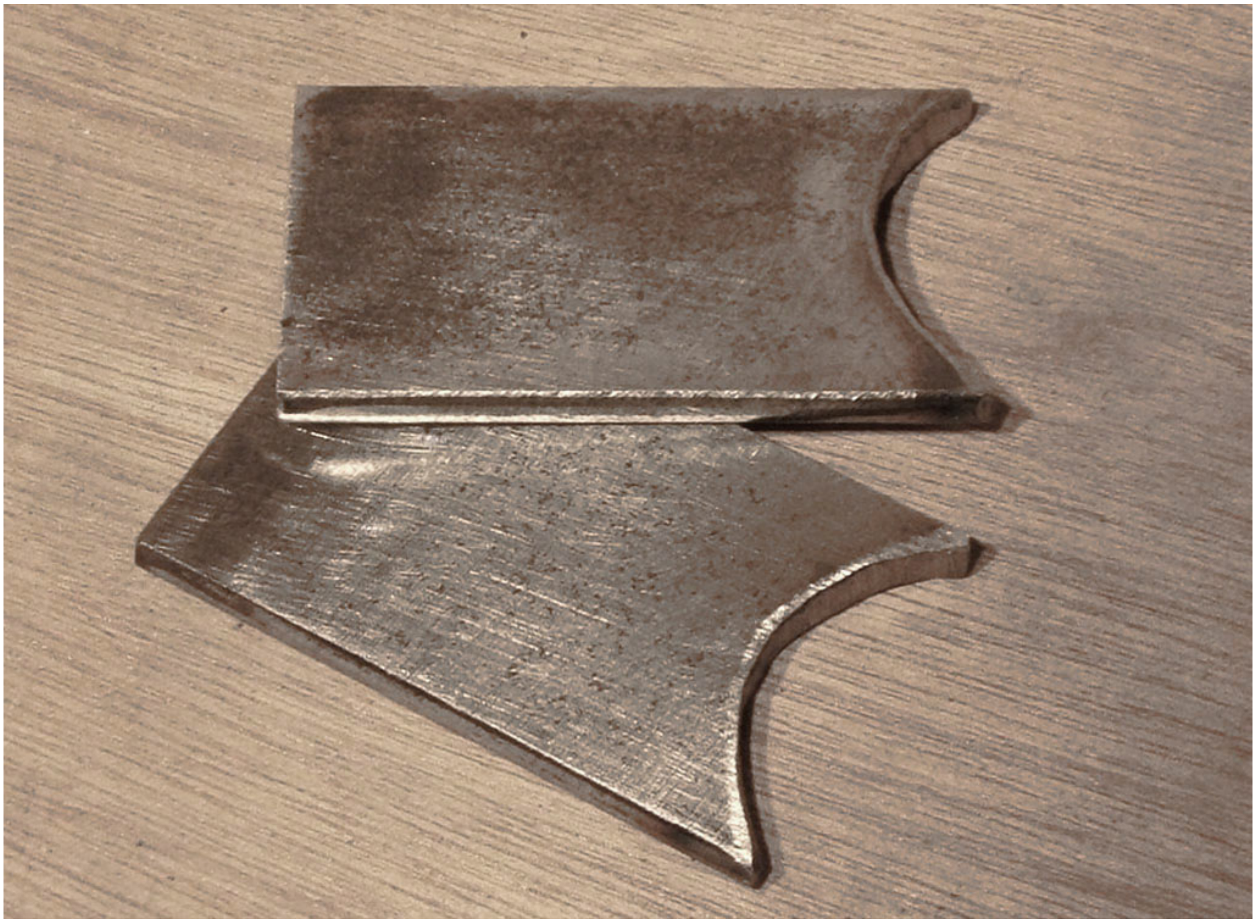


Figure 147 - Fish-mouth cuts for the bottom bracket

Trace around the bottom bracket shell to draw a line on the plate as shown earlier in Figure 147. The marker line should meet the corners of the plate to ensure that you don't cut out too much off of the plate when grinding out the rounded area. If you take too much metal away from the plate, there will not be enough room between the bottom bracket and the clamping bolts for the main boom.

When grinding out the traced circular area for the bottom, place both plates in the vice so that they can be done at the same time. This will ensure that both plates are exactly the same size. Try to make the gap as small as possible around the bottom bracket shell so that there is less distortion as the plates are welded. If the bottom bracket becomes overly distorted, it will be a serious challenge trying to screw the hardware back into the bottom brackets without stripping the threads. The completed plates are shown in Figure 147 after grinding them to be exactly the same.

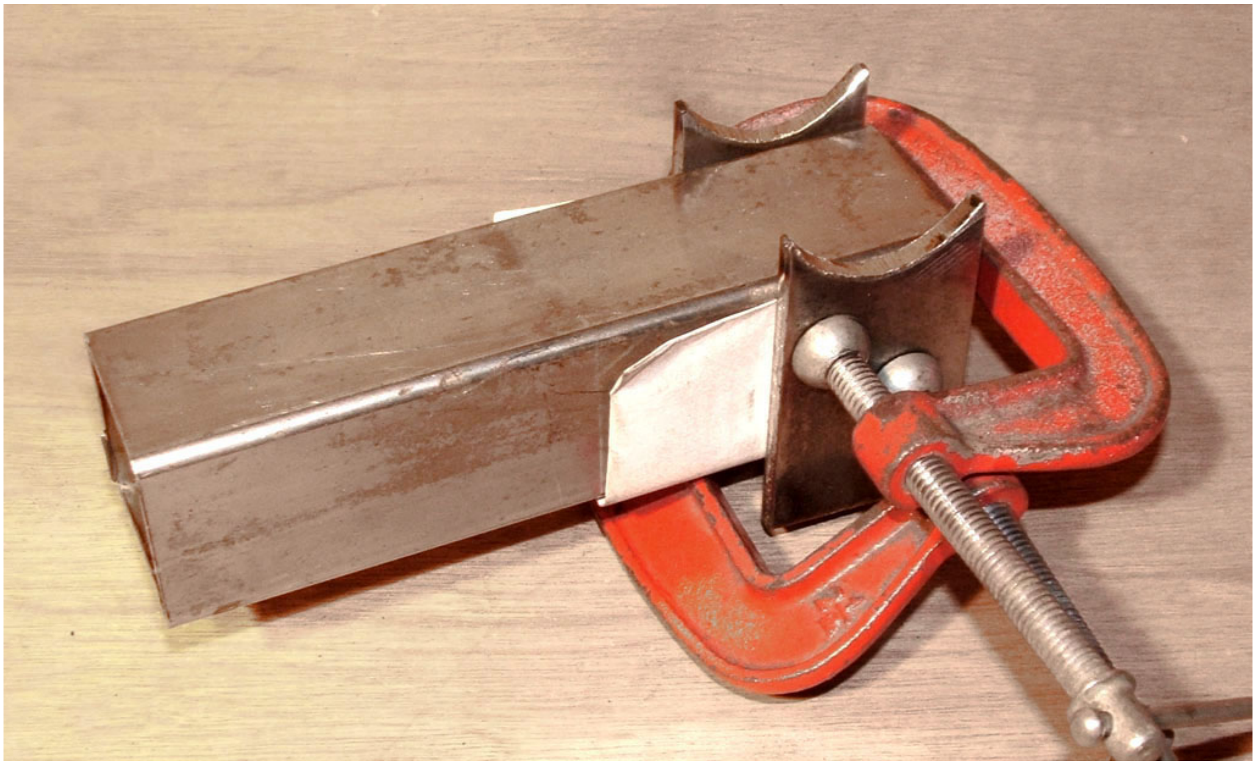


Figure 148 - Aligning the two plates

To get the two plates aligned with each other and at the correct spacing, a bit of frame tubing can be clamped between the two plates as shown in Figure 148. This will allow you to set the bottom bracket into the correct position for tack welding and ensure that both plates are aligned with each other so the bolt passes easily through both holes. I also placed a sheet of paper (folded in half) between each plate and the side wall of the tubing to allow a little clearance between the clamp plates so that the unit is not too difficult to slide when making adjustments. Without the small gap, it is easy to scratch the paint if you plan to adjust the bottom bracket around a few times.

✓ Builders Tip

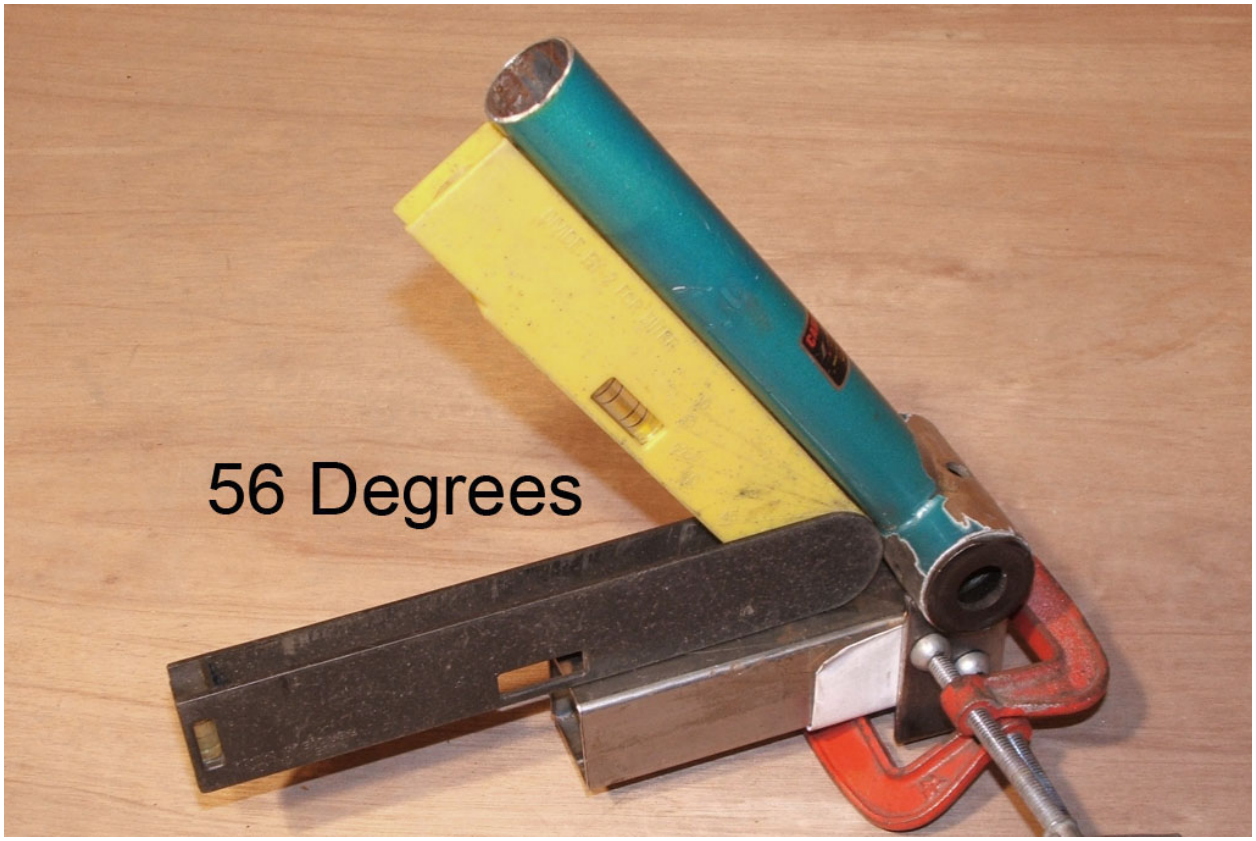


Figure 149 - The front derailleur tube angle

As shown in Figure 149, I used an adjustable square set to the required 56 degrees in order to set up the bottom bracket and derailleur tube to place two small tack welds at the top of the joint. It may be a bit tricky to get the first tack weld in place while holding the bottom bracket in position, but once this is done, the rest is easy.

With the piece of frame tubing as a guide, you will automatically have the correct distance between the plates. Now, you will need to ensure that there is approximately equal distance between each plate and the edges of the bottom bracket. In other words, the bottom bracket will be in the center of the main boom as viewed from above.

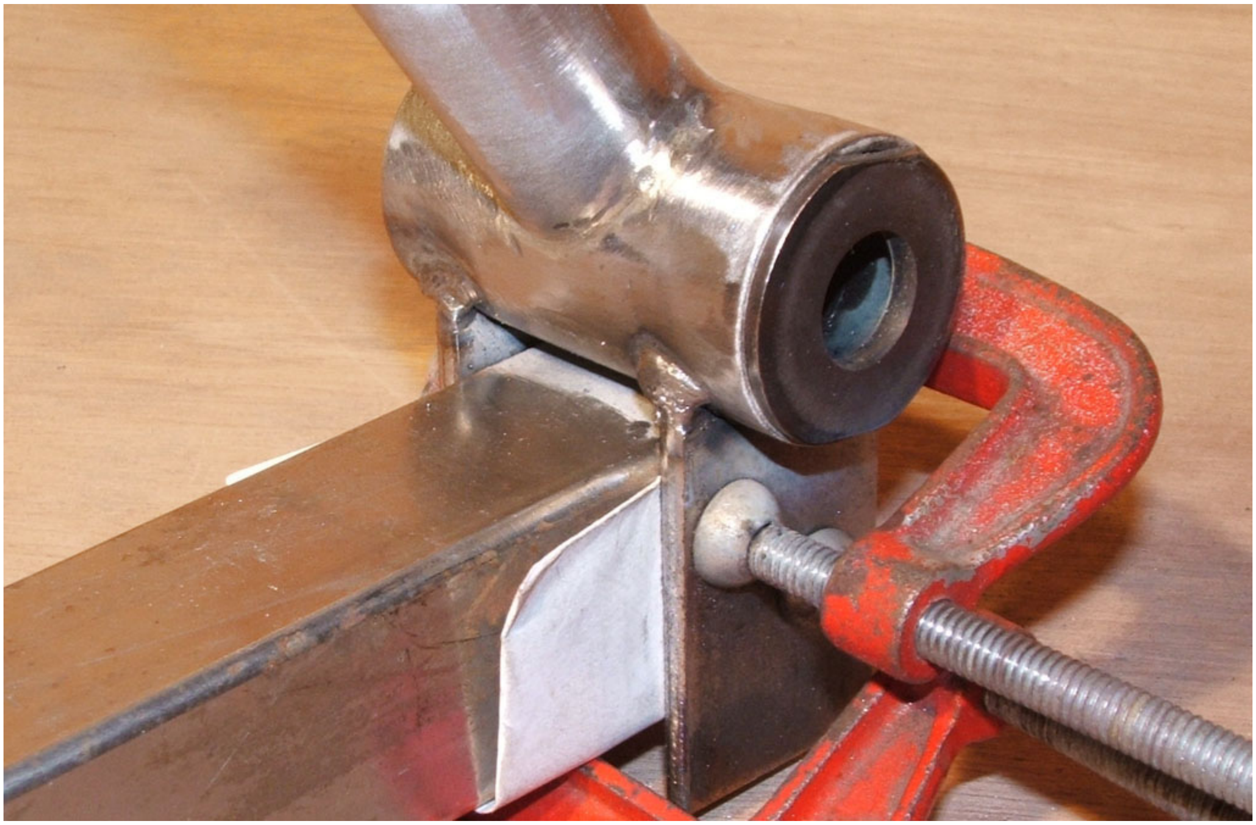


Figure 150 - Tack weld the bottom bracket plates

Figure 150 shows the first tack welds done at the top edge of the clamp plates to secure the parts together. Ensure that the derailleur tube angle is close to 56 degrees and that the bottom bracket is at 90 degrees to the square tubing. Welding is only done on the outside of the joint, not between the plates. If the inside of the joint is welded, the weld bead will not allow the bottom bracket to sit directly on the frame tubing and could cause alignment problems. Because of the way the clamp system works, there would be no added benefit from welding the inside of the joint anyway.

The folded piece of paper has been installed between the plates and the 1.5 inch tubing to act as a small spacer. This tiny bit of extra space will take into consideration the extra thickness added to your frame by the paint and primer. Without this extra gap, you will scratch your paint when first installing the bottom bracket assembly.

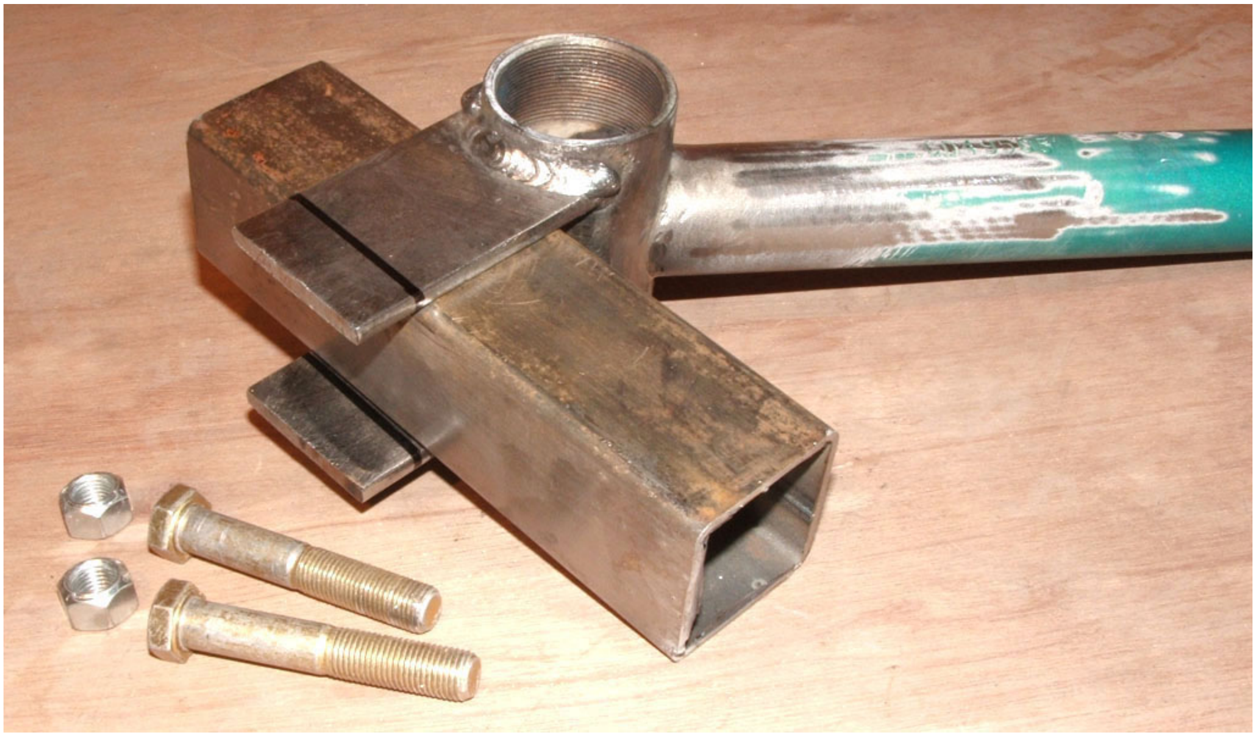


Figure 151 - Mark a line to drill the bolt holes

The two plates will form a vice-like grip on the frame tubing when the 1/4 inch bolts are tightened. To drill the holes into the plate, draw a line that represents the bottom corner of the frame tubing as shown in Figure 151. Now, you can punch and drill the holes using the line as a guide that will allow you to make sure the holes stay below the line. If the holes are not below the line, you will not be able to pass the bolts through both plates because they will hit the frame tubing instead.

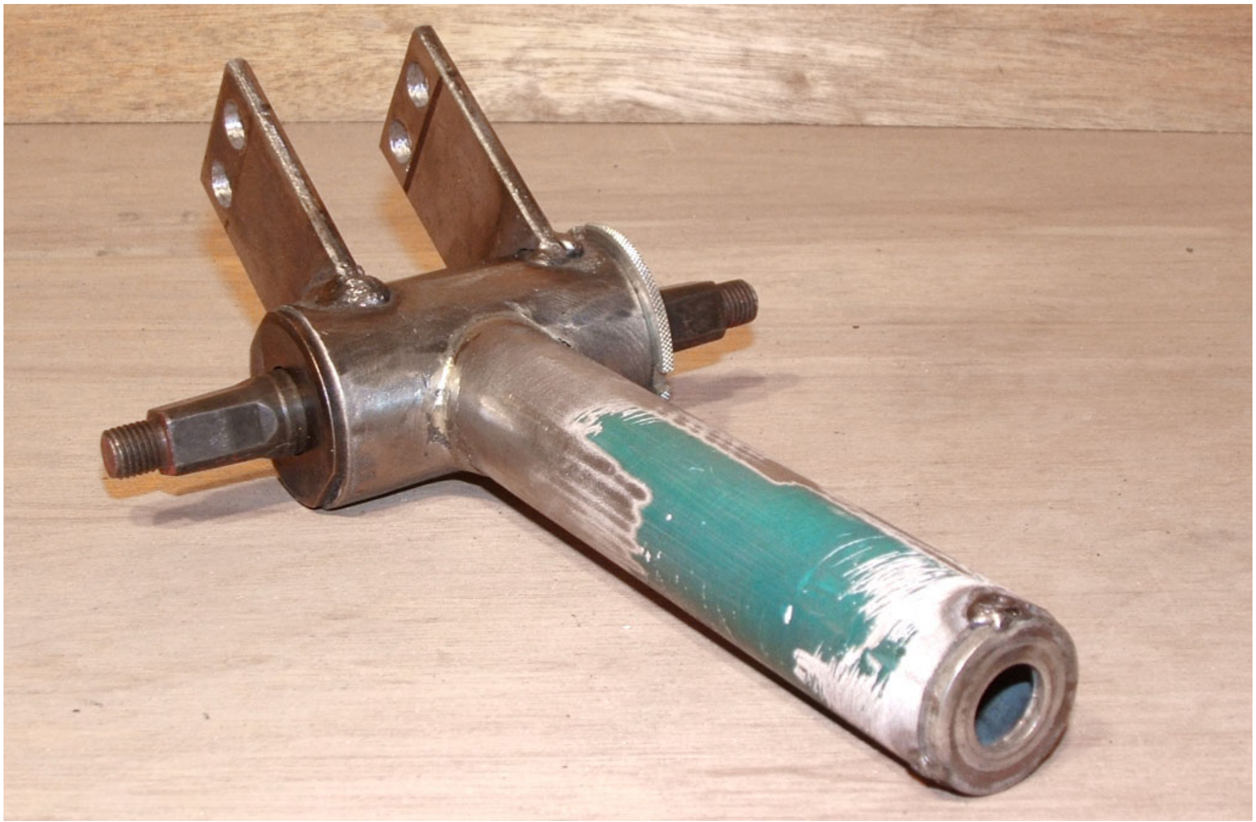


Figure 152 - – Capping off the open tube

Later on when you have you chain ring and front derailleur installed and tested, it is a good idea to cap off the open end of the tubing so that it looks better and keeps moisture out. As shown in Figure 152, a washer is welded over the end of the tube and then completely filled in around the joint and the hole. To fill in the washer hole, several passes are made around the edge until completely covered in weld metal.

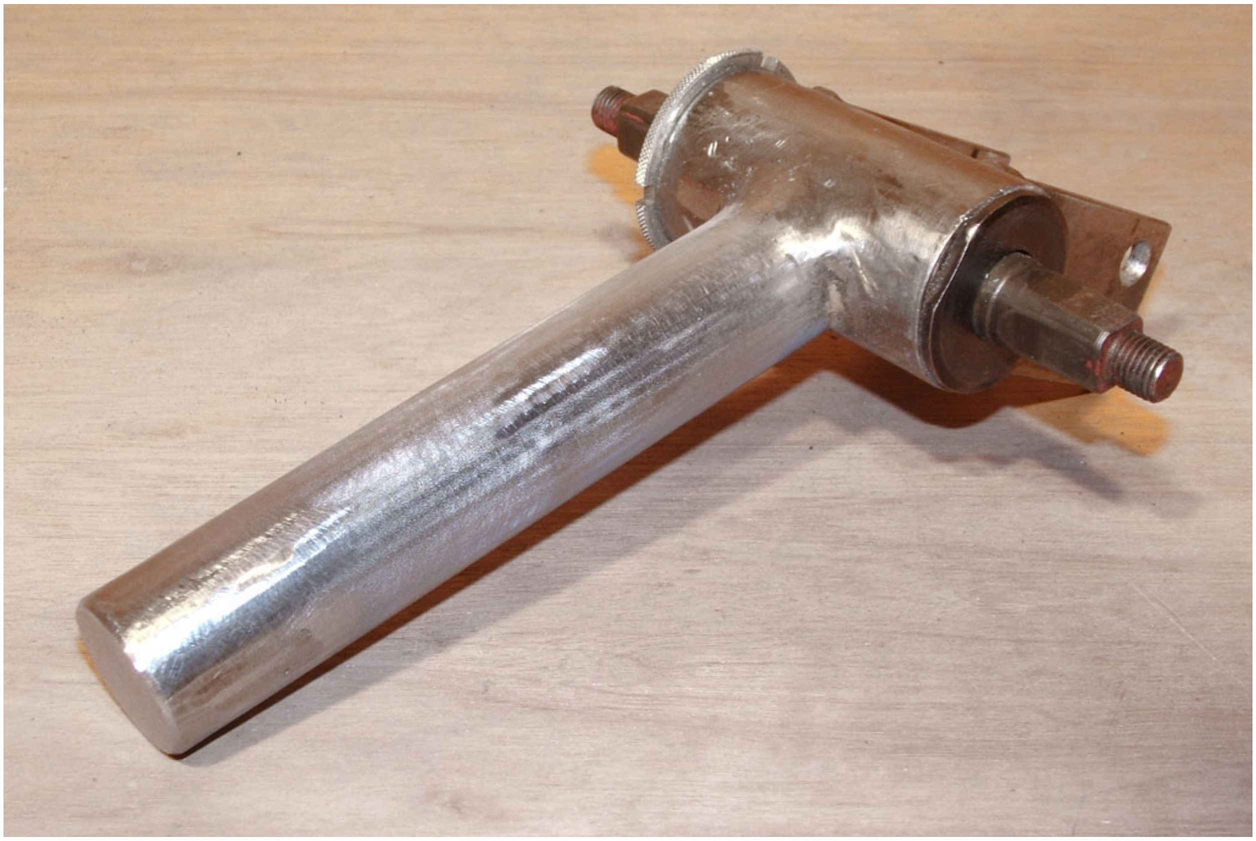


Figure 153 - Adjustable bottom bracket completed

After welding the washer in place and grinding the area clean, you can't even tell the tube shown in Figure 153 once had an open end. Going the extra distance can make your final product look very professional, possibly even better than some mass produced machines that have plastic plugs shoved into the open ends of the tubing.

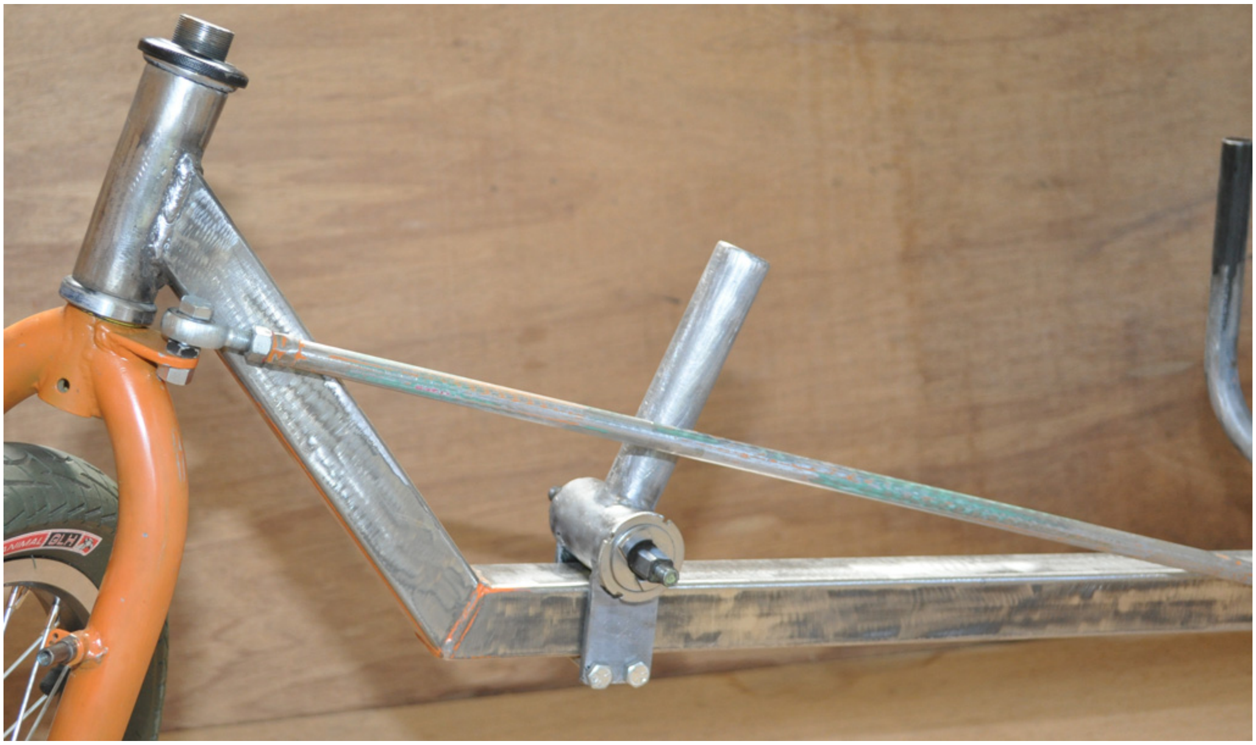


Figure 154 - Installing the bottom bracket assembly

The sliding bottom bracket assembly will live near the front of your main boom as shown in Figure 154, locked into place by the two bolts that squeeze the plates against the frame tubing. When tightening the nuts, turn one at a time until the bottom bracket is securely clamped to the frame. Don't tighten the nuts so much that you begin to crush your frame though - just enough to keep the bottom bracket from moving under pedaling stress.

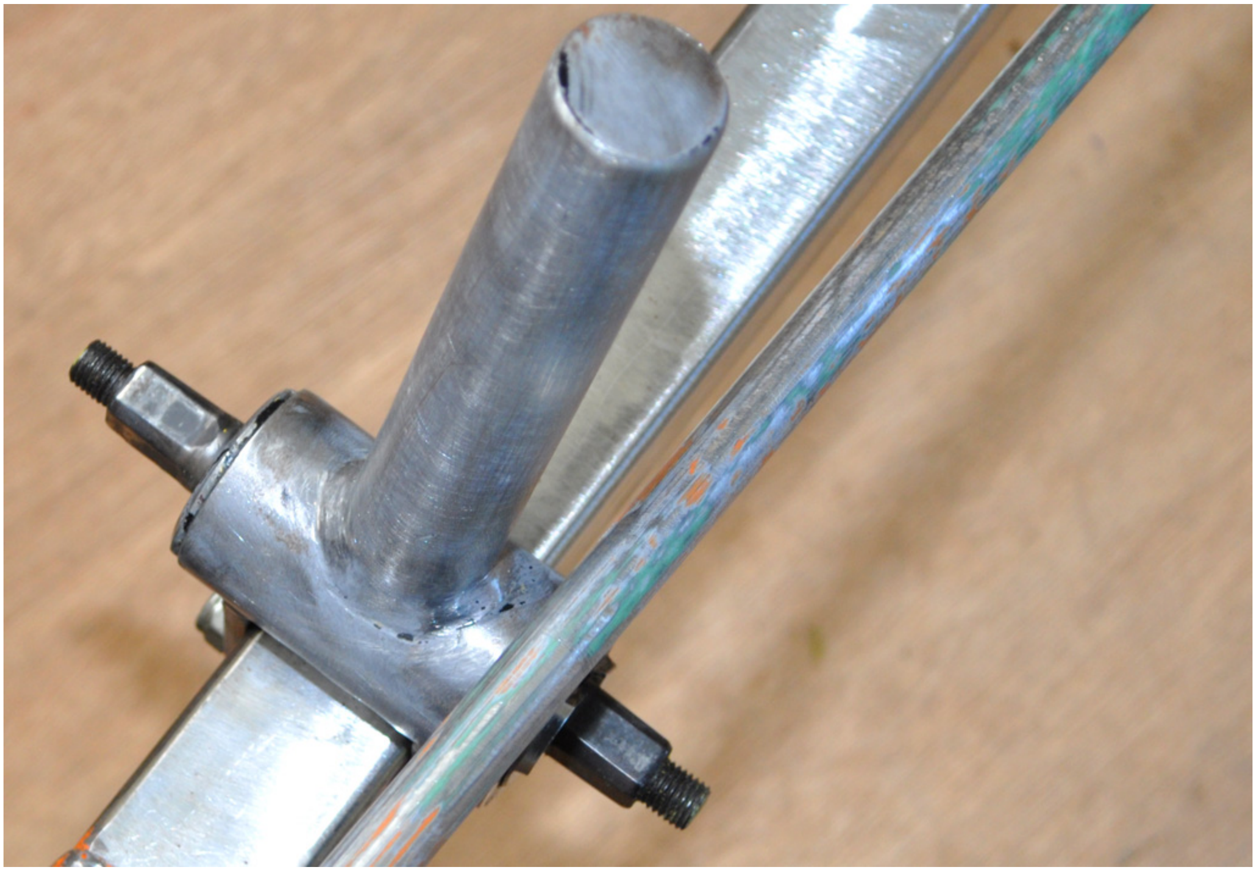


Figure 155 - Checking the connecting rod clearance

You should have just the right amount of clearance between the front derailleur tube and connecting rod (Figure 155) so that steering at any angle does not cause any interference between the two. There will also be enough clearance between the connecting rod and the left crank arm as well.

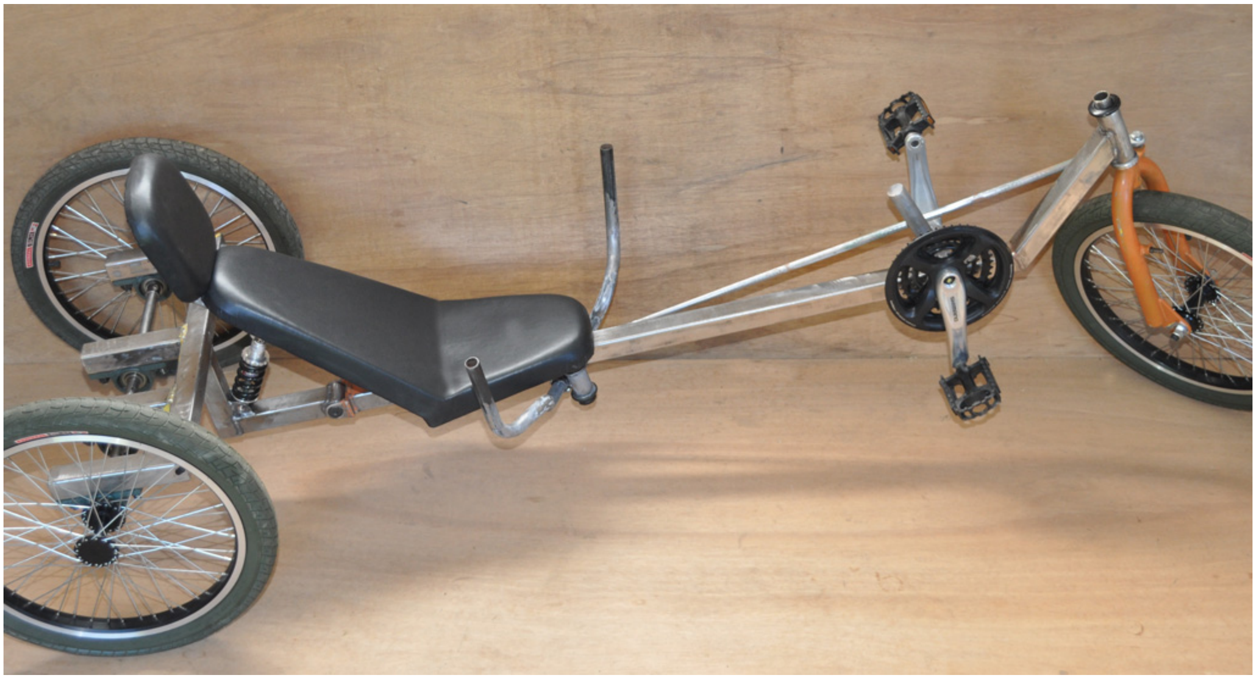


Figure 156 - Finding the optimal bottom bracket position

Now is a good time to install your cranks and figure out the optimal position of your bottom bracket along the main boom. At this point, you can move the sliding bottom bracket assembly around without any risk of paint scratching, so find your optimal position and mark this down for later. Figure 156 shows my bottom bracket assembly set up for my leg length.

THE REAR FREEWHEEL

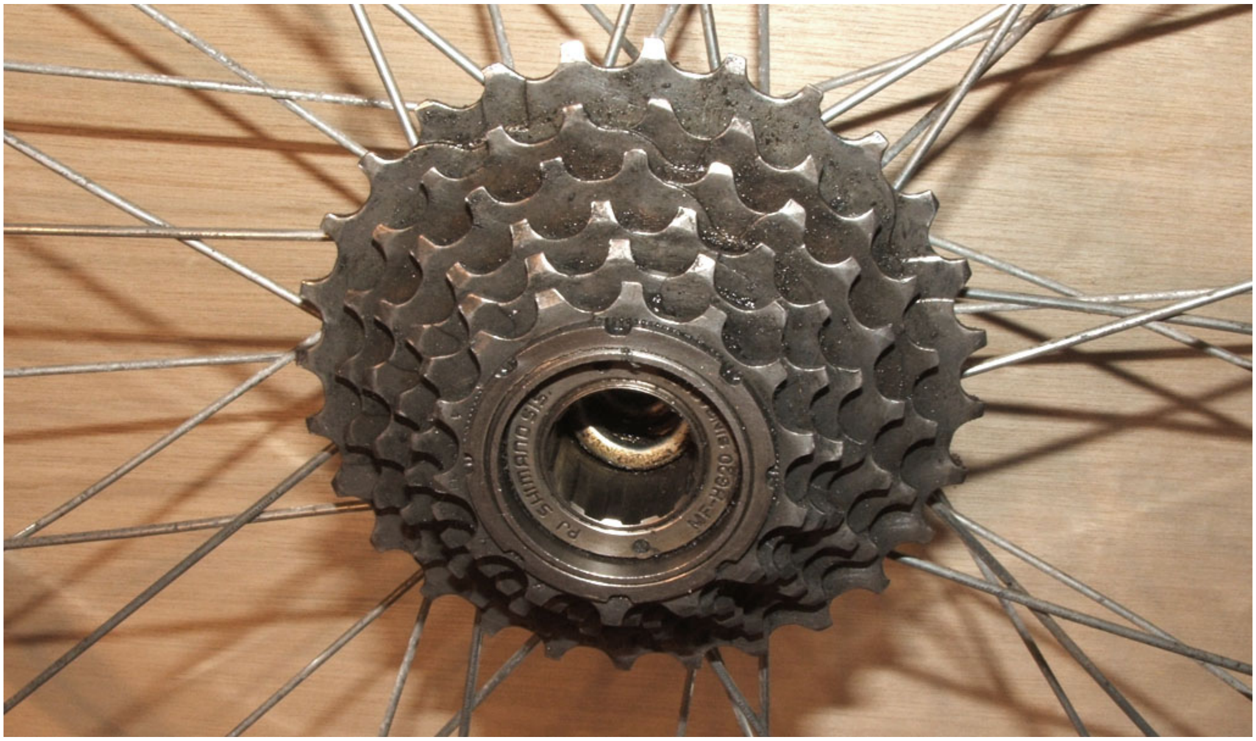


Figure 157 - A Shimano style threaded freewheel

The Aurora Trike has a transmission identical to that of a regular bicycle, so you will need the same components in order to make it work. A freewheel is a cluster of chain rings mounted to a one way ratchet that allows pedaling forced to be transferred to the wheel only in the clockwise rotation. There are two common types of multispeed freewheels: a cassette style unit that allows for the removal of only the chain ring portion of the freehub from the hub, and a thread-on type that can be completely removed from the hub body. The threaded freewheel is easily identified by the spline inside the front as shown in Figure 157. This spline is there to allow a special tool to grip the freewheel body for removal. I don’t like buying special tools, so I will show you how to make your own freewheel remover for free that will outlast a store bought tool.

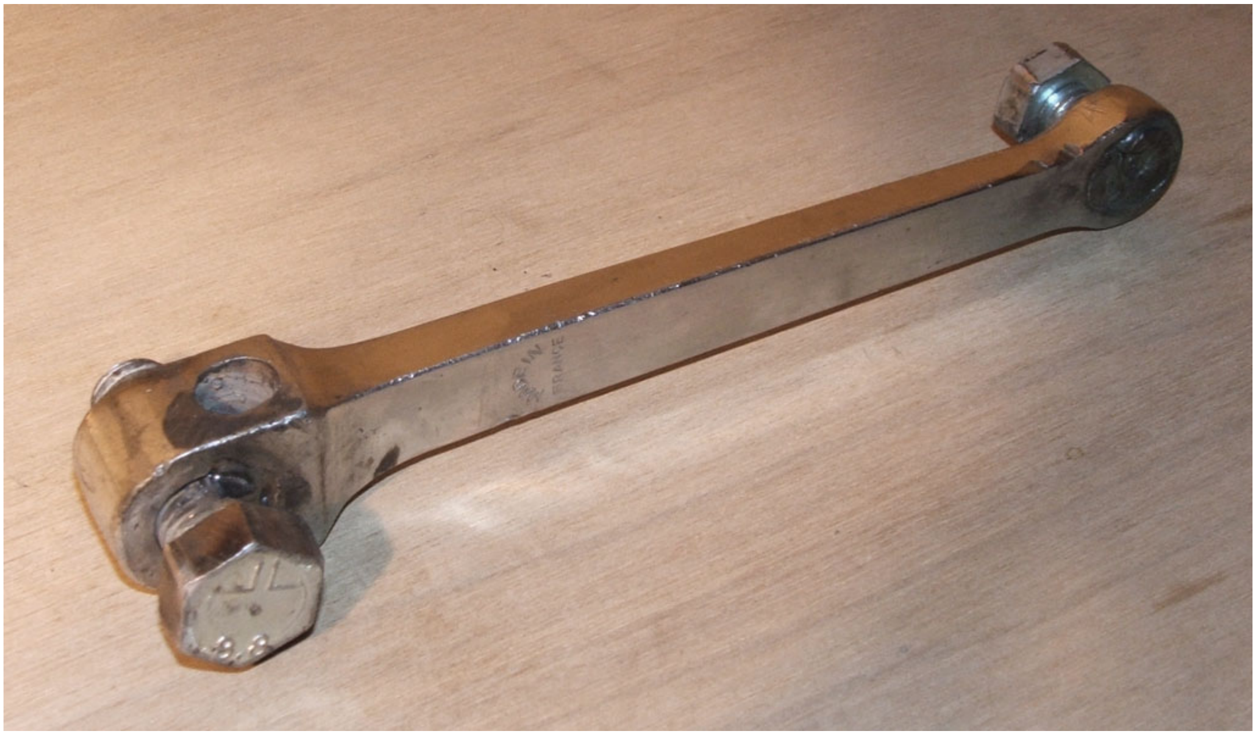


Figure 158 - A simple cheap freehub removal tool

Find a bolt that will fit snugly into the Shimano type freewheel spline, or grind one down that was originally slightly too large until it can be tapped into the spline with minimal force creating a tight lock. This bolt is then welded to an old steel crank arm or similar steel rod to create the indestructible freewheel remover that will take any amount of hammer pounding you need to apply in order to remove the old freewheel from the threaded hub. Believe me when I say it may take extreme force to unscrew that freewheel. I usually pound on this tool with a large hammer while holding the rim on the ground.

Builders Tip

Oh, and you should always remove the freewheel with the rim attached or you will have no chance of holding it, a vice will not hold the hub, trust me. The tool shown in Figure 158 is many years old and has removed more old freewheels than I care to count. For the record, I broke two store bought freewheel removers in one month before building this tool. Yes, DIY is king!

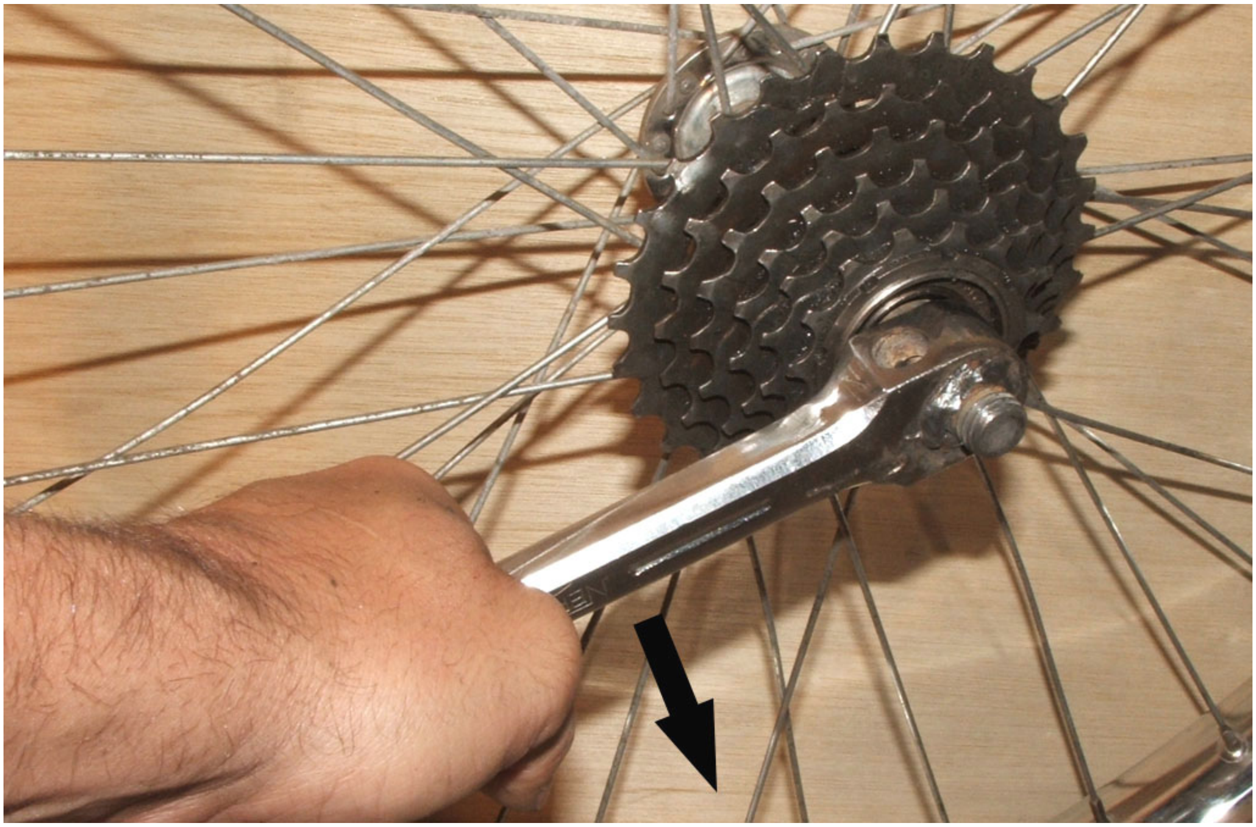


Figure 159 - Unscrew a freehub using counterclockwise torque

Bang the bolt into the spline on the freewheel and then grab the rim between your legs or stand on a part of the rim to hold it from spinning under the force. You will probably not be able to crank out the freewheel by hand unless it is brand new and has not seen much pedaling force. Older wheels will have their freewheel cranked on tightly from years of torque and possibly some rusting as well. Counter clockwise is the direction of removal as shown in Figure 159, just like any bolt, so ensure that you are hitting the correct side of the tool. With a little patience, the freewheel will start to unscrew, and the tool always wins. A very long pipe over the handle is also good for increasing your leverage if you can find a way to secure the wheel in place.

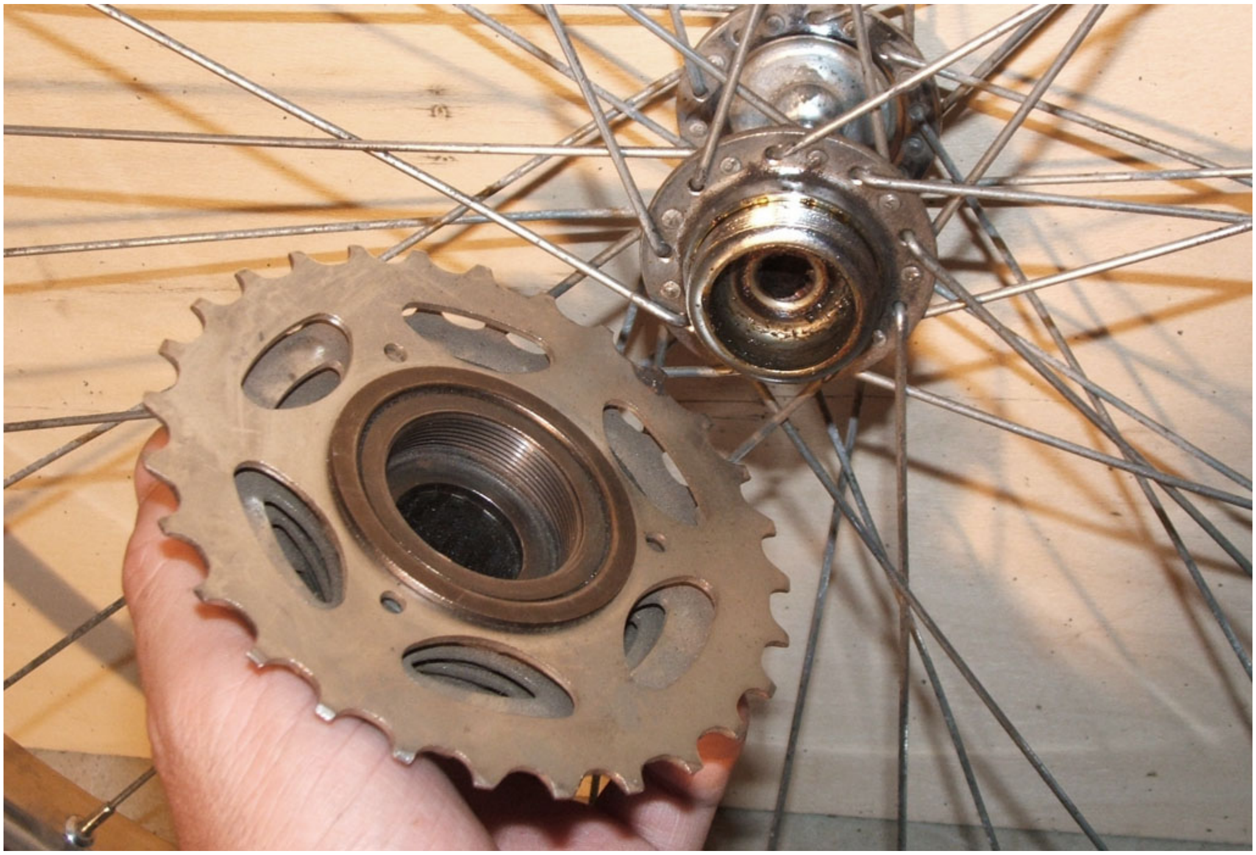


Figure 160 - Removal of the threaded freehub

Figure 160 shows what the inside of the freewheel looks like once it unscrews from the hub. Notice the fine threads on the inside of the ratchet hardware - we will be using these to mount the freewheel to the rear axle.

THE AXLE ADAPTERS

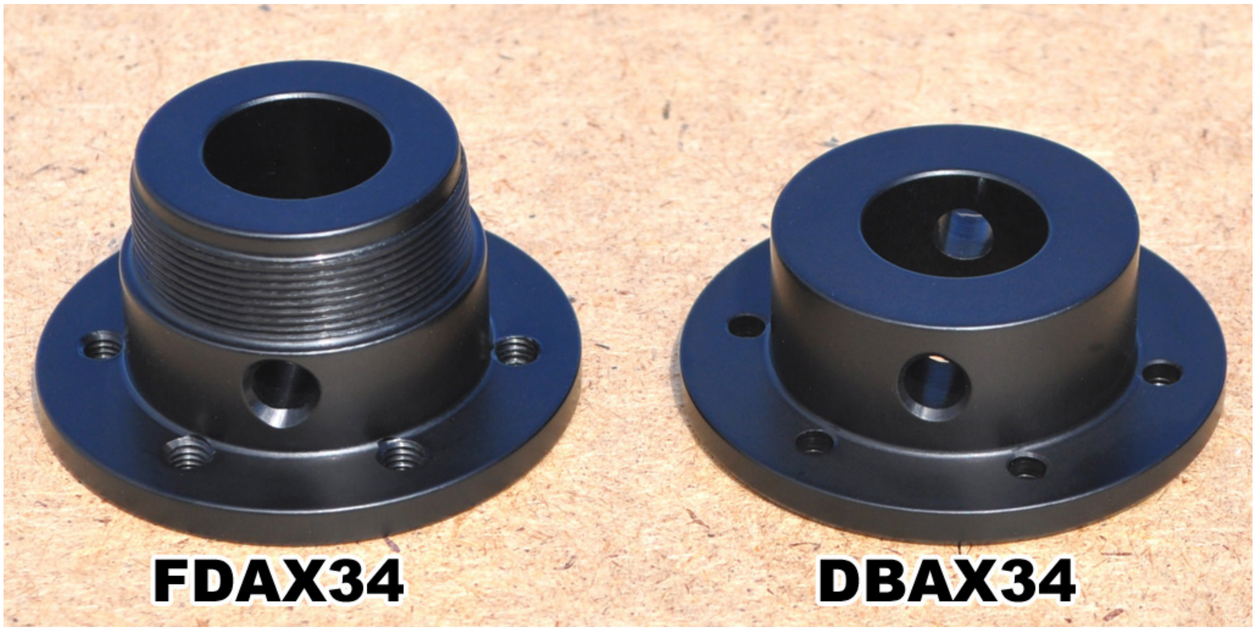
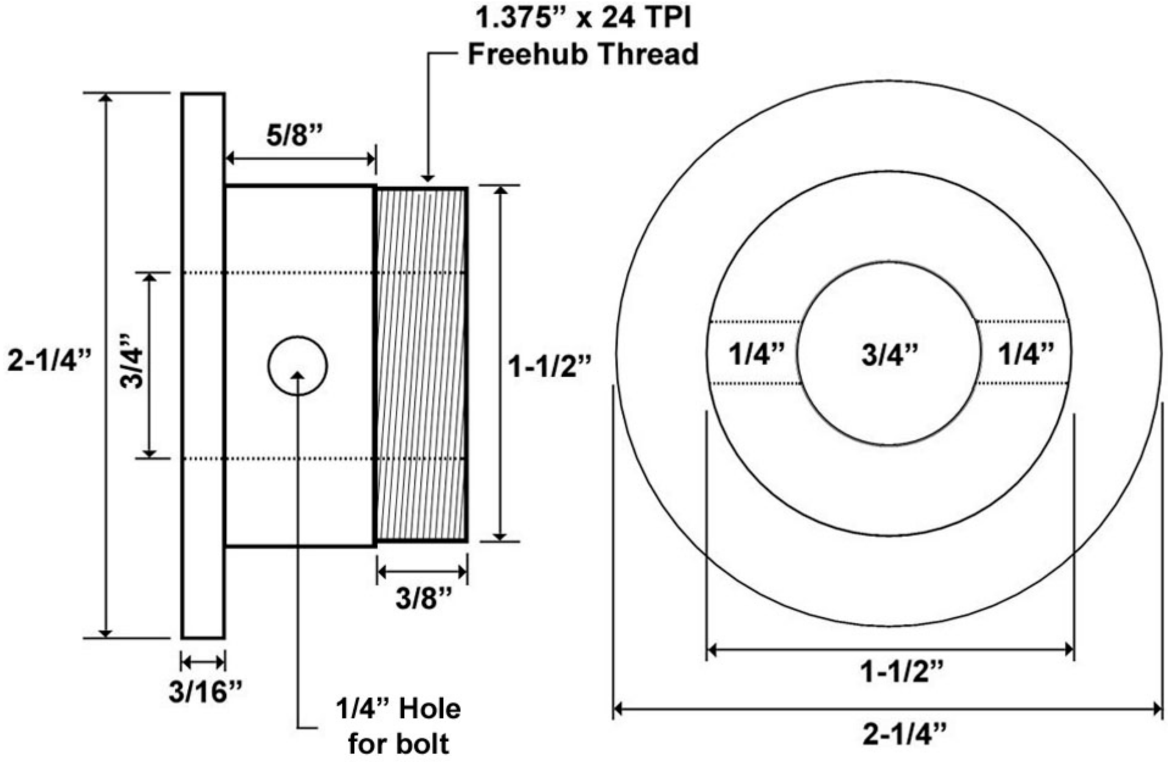


Figure 161 - Freewheel and disc brake adapter parts

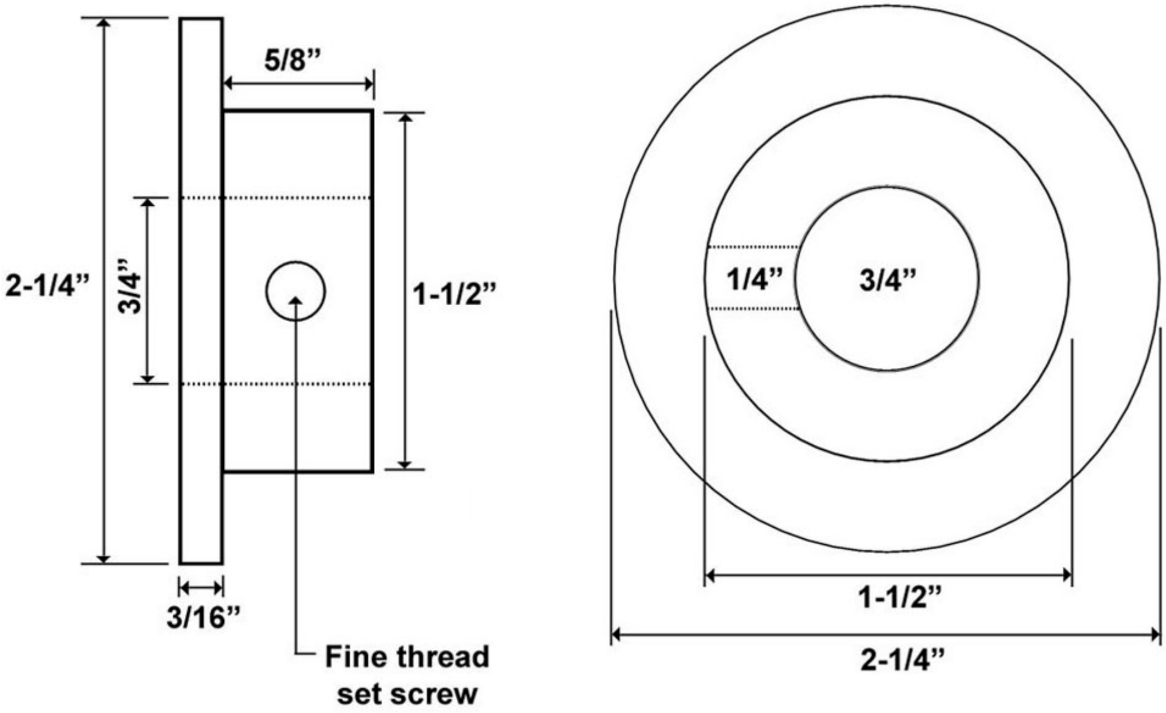
To adapt a standard bicycle freewheel and a set of disc brakes to the 3/4 inch rear axles on the Aurora Trike, you will need a pair of simple machined parts. Figure 161 shows the two machined parts that will mount the Shimano style thread on freehub and the disc brakes to each rear axle. The part shown on the left (FDAX34) allows a threaded Shimano style freewheel and a standard bicycle disc brake to be mounted to the drive axle on your trike. The part shown on the right (DBAX34) allows the installation of a second bicycle disc brake onto the other axle.

After many requests, we are manufacturing these parts in high quality anodized aluminum and they are available for sale on our website by clicking on the Parts menu. Of course, you can have these parts made by any machine shop in your area willing to take on a small job and they can be made of steel or aluminum.



Drawing 6 - The Freewheel / Disc brake axle adapter part

If you intend to have your local machine shop make these parts for you then print out drawings 6, 7 and Figure 161 so the machine shop will know exactly what you want them to make. Also, it is always a good idea to bring the freehub and the disc brake along with you to the machine shop for reference, especially due to the fine freehub threads. If you plan on having the machine shop drill and tap the brake holes, then add the correct bolt circle to the drawing, or hand them the disc and explain how it will bolt to the flange. Not all disc brakes have the same bolt circle, and the so called "standards" are constantly changing, so having the discs you plan to use before drilling the holes is a good idea. The part is not difficult to machine, so it should be fairly inexpensive to have done. If you plan on experimenting with rear drive trikes or quad cycles of your own design in the future, this really is the ultimate part to have around, so you may even consider having more than two made.



Drawing 7 - The disc brake axle adapter part

As shown here in Drawing 7, the disc brake adapter for the right side axle is almost the same as the freehub adapter with the exception of the threaded section. Both parts will be drilled to match your disc brake rotor pattern, which is likely an M5 size bolt using the ISO 6 bolt mounting standard.

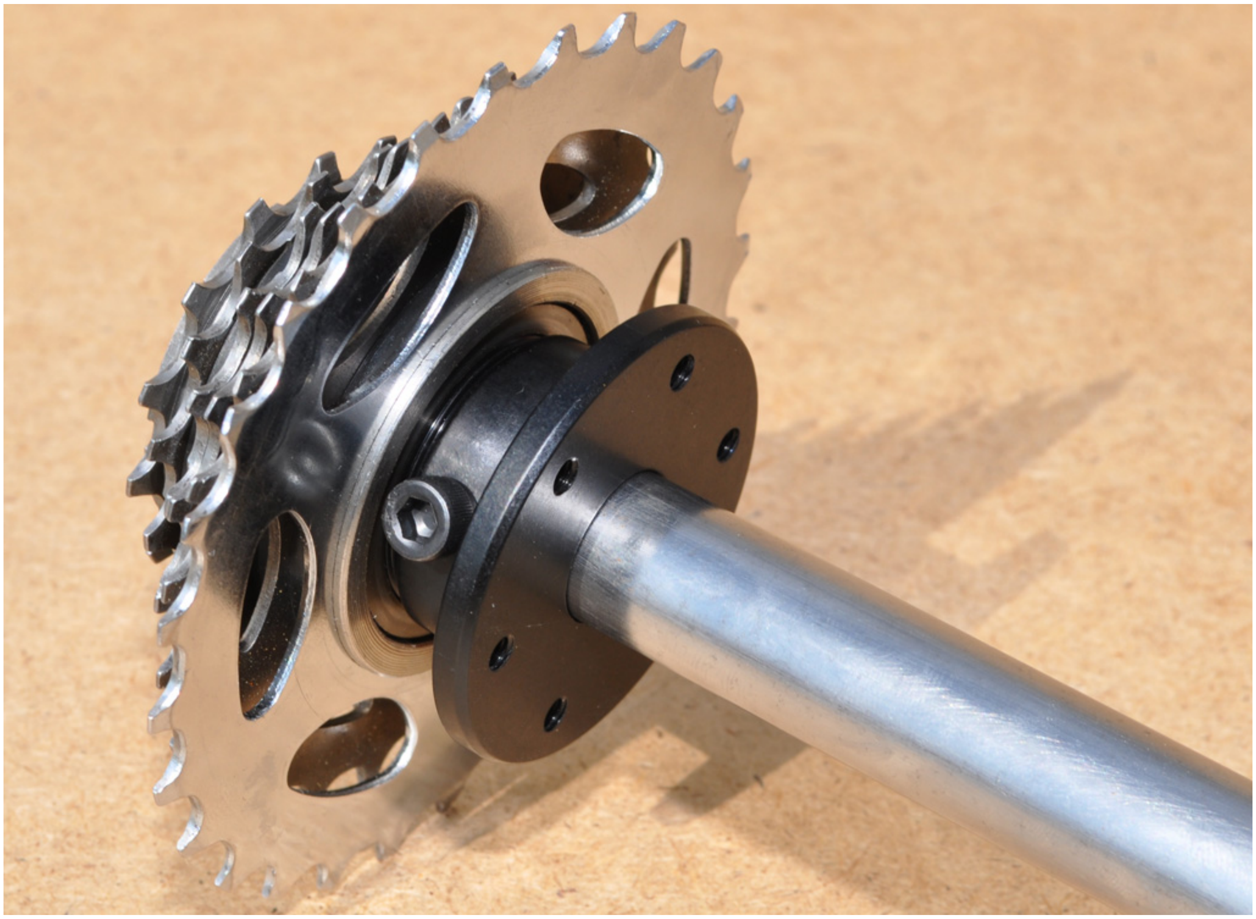


Figure 162 - AtomicZombie FDAX34 Freewheel Trike Axle Adapter

Our Delta Trike Axle Freewheel Adapter fits onto any 3/4 inch axle and allows the installation of a standard Shimano style thread-on freewheel and bicycle disc brake rotor. With this part, you can add a pedal transmission to any trike or quadcycle using only standard bicycle components. The included locking bolt secures the part to the axle and allows for easy removal at a later time. The six disc rotor mounting holes are also tapped so you can mount your bicycle disc brake rotor using the standard M5 bolts that were supplied with it. The FDAX34 Delta Trike Axle Freewheel Adapter is a high quality machined part made of aluminum and anodized black.

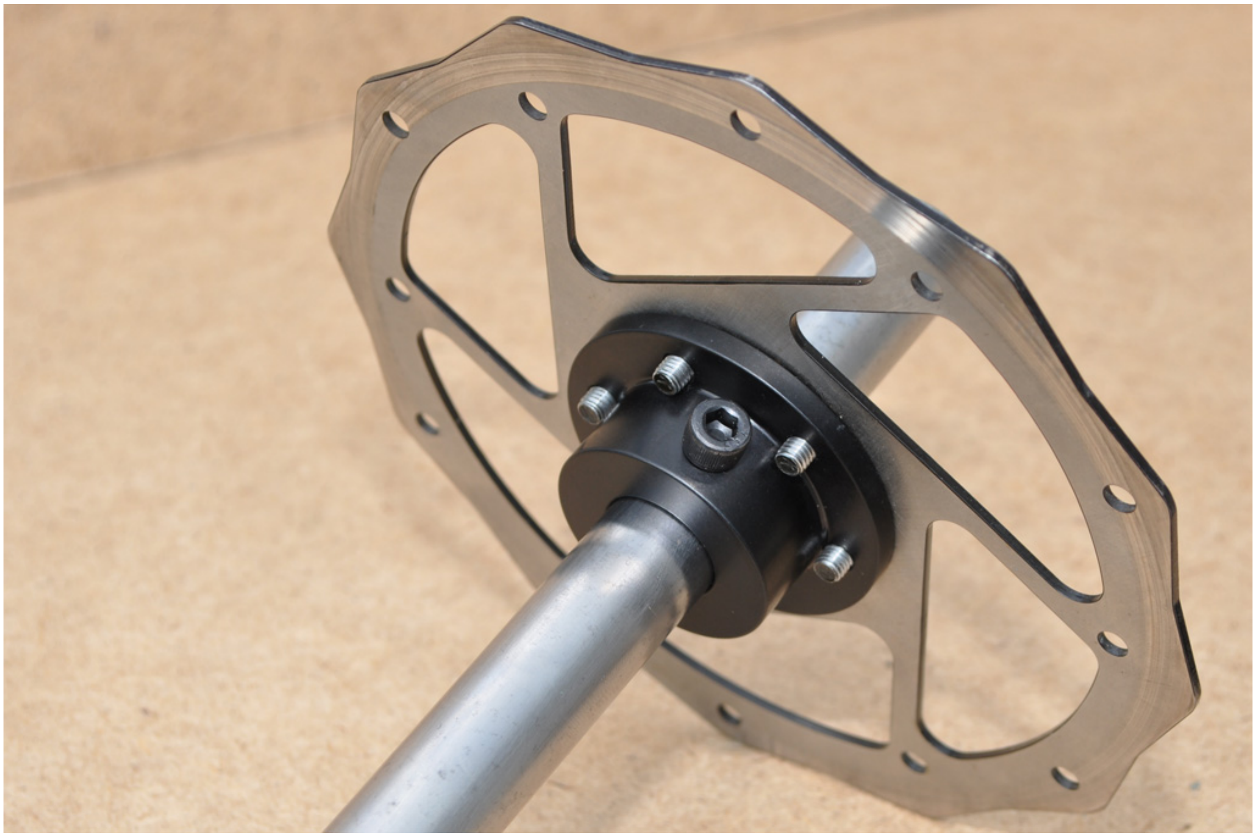


Figure 163 - AtomicZombie DBAX34 Disc Brake Trike Axle Adapter

Our Delta Trike Axle Disc brake Adapter fits onto any 3/4 inch axle and allows for the installation of a standard ISO standard 6 bolt bicycle disc brake rotor. With this part, you can add reliable disc brake stopping power to any trike or quadcycle using only standard bicycle components. The included locking bolt secures the part to the axle and allows for easy removal at a later time. The six disc rotor mounting holes are also tapped so you can mount your bicycle disc brake rotor using the standard M5 bolts that are supplied with it. The DBAX34 Delta Trike Disc Brake Adapter is a high quality machined part made of aluminum and anodized black.

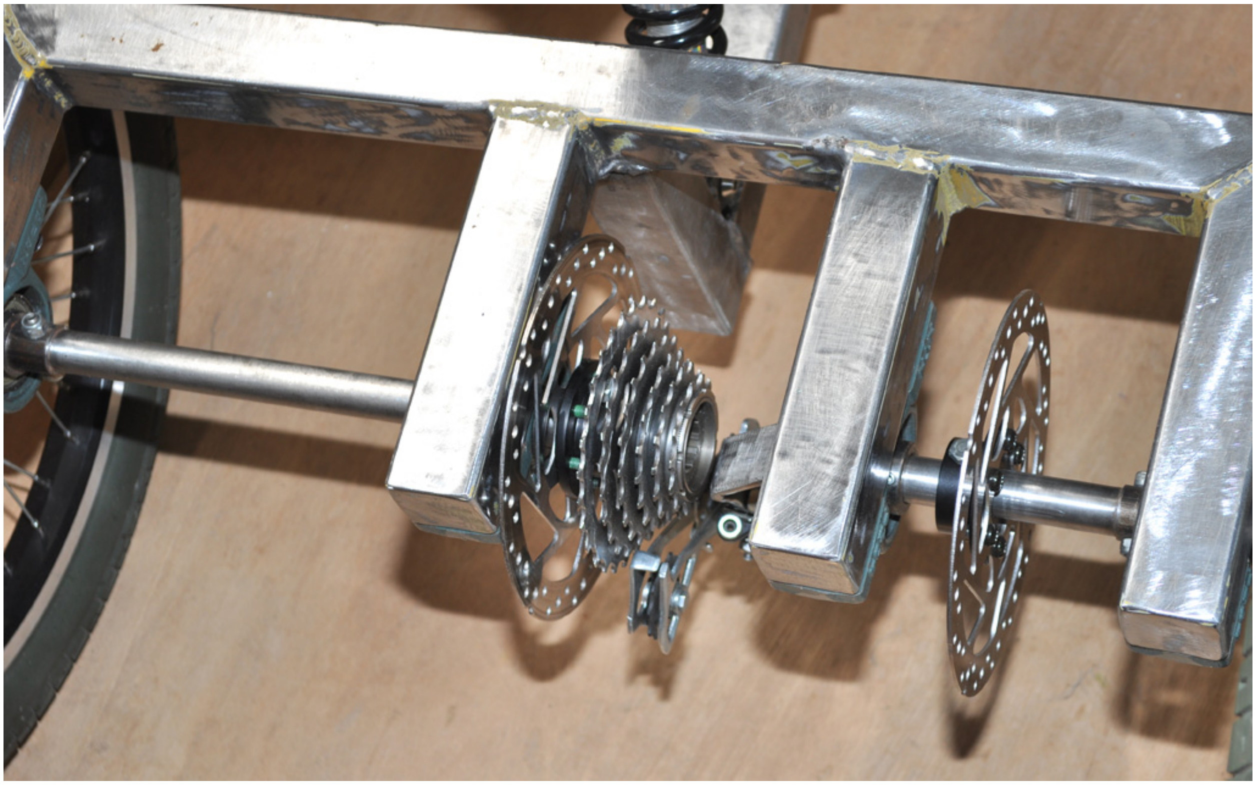


Figure 164 - The axle adapter installed on the trike

The two machine parts are installed on the rear axles as shown in Figure 164, with the freewheel adapter (FDAX34) on the left axle and the disc only adapter (DBAX34) on the right axle. The position of the freewheel adapter should place the disc brake rotor about an inch away from the frame tubing so you have some room to install your disc brake hardware. A close-up photo of this mounting position can be seen in Figure 170. The disc brake only adapter can be placed in the center of the right axle between the two axle mounting tubes as shown in Figure 164.

To secure the adapters to the axle, a 1/4 inch hole is drilled through the axle so a bolt can be placed through the holes in each adapter to fasten the parts to the axle. Use a marker to mark the point on the axle where you need to drill the hole by placing the adapters in the correct place and then by marking the axle through one of the bolt holes in the adapter. You can drill the 1/4 inch hole through the axles using a hand drill if you are accurate with hand tools, but a drill press is certainly going to make this job easier.

THE REAR DERAILLEUR

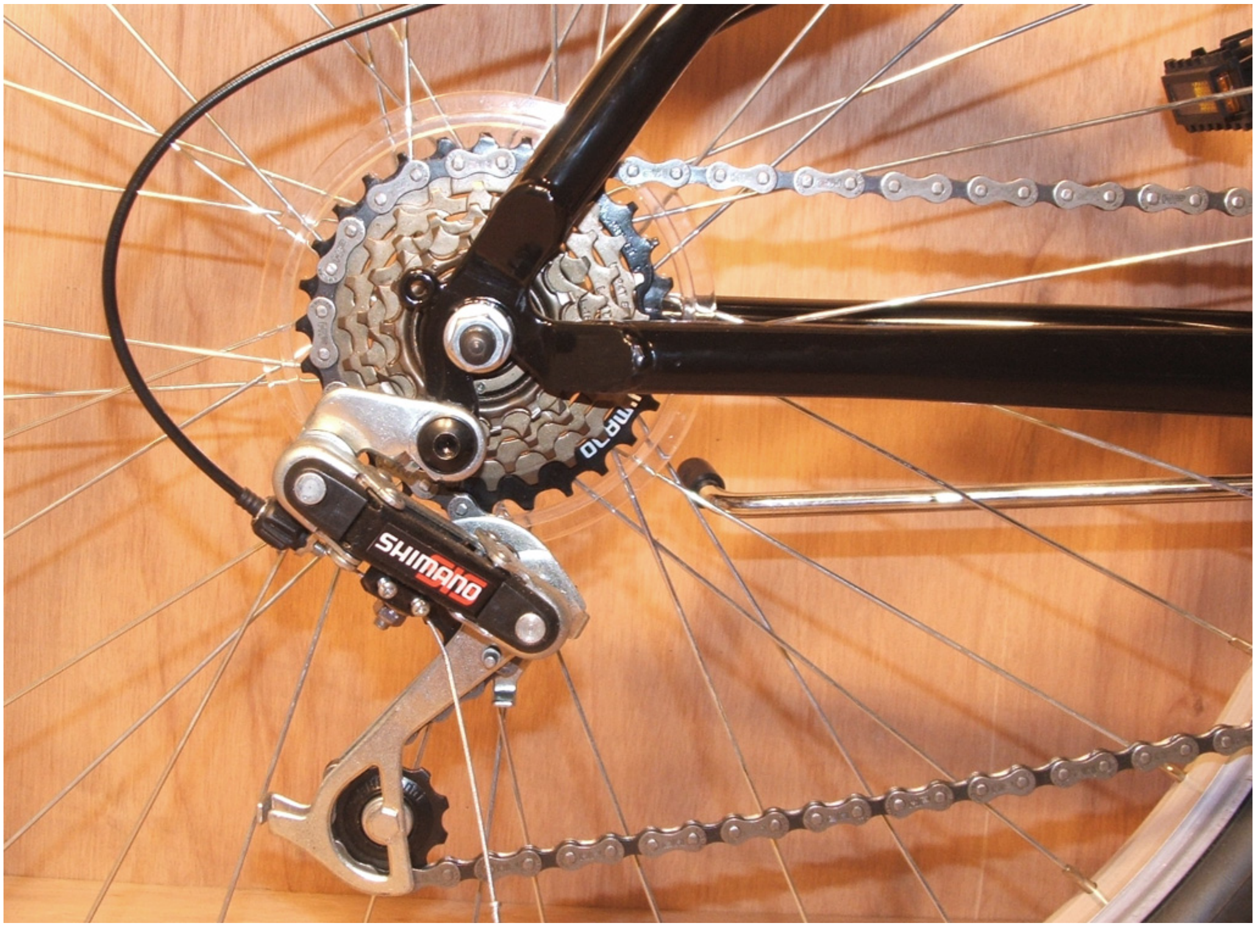


Figure 165 - The position of a rear derailleur

There is no rear dropout or threaded axle to mount your rear derailleur on the Aurora, so you will need to "hack" something together to do this. A rear derailleur should be in the position shown on the standard bicycle in Figure 165. This position will allow you to reach the full range of gears and allow the derailleur to function normally. There are many ways to achieve this goal, but I find that cutting and modifying the derailleur mounting hardware is the easiest method.

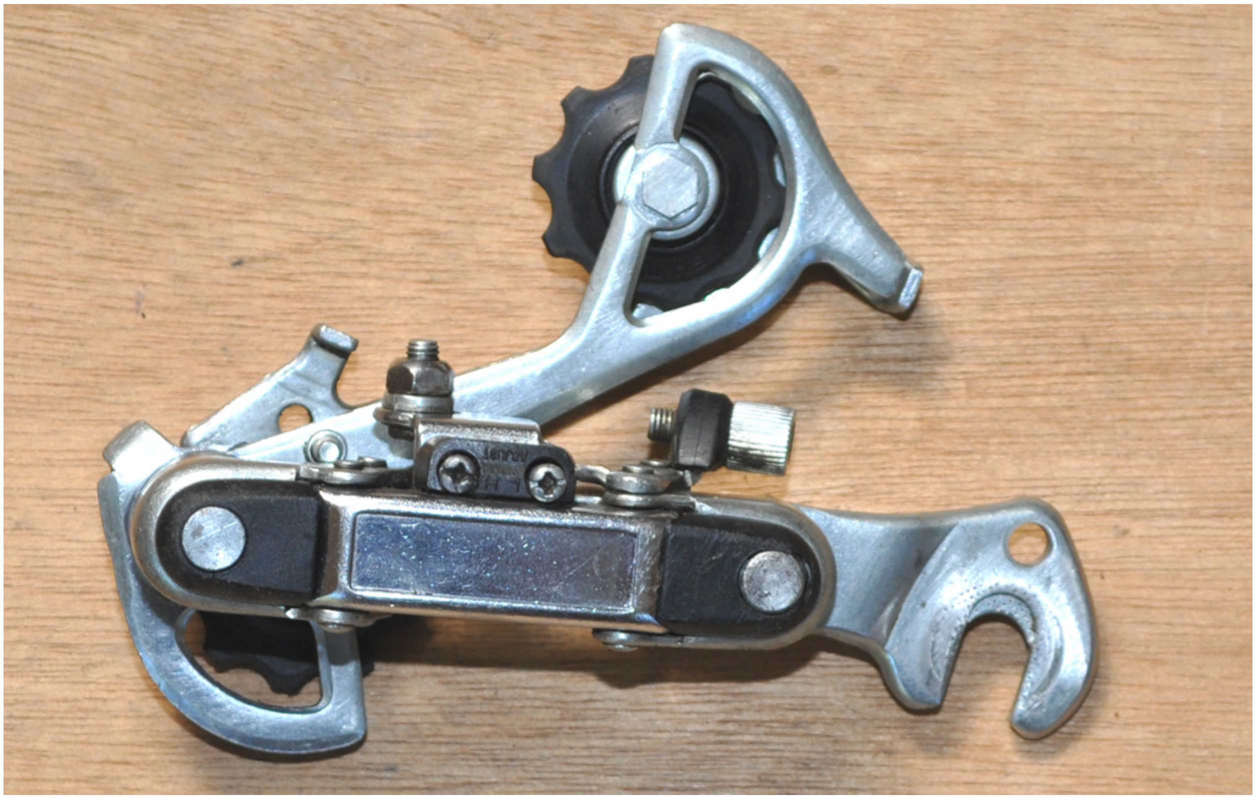


Figure 166 - A rear derailleur with a dropout mount

Rear derailleurs come in two basic varieties - one that has a dropout mounting slot like the one shown in Figure 166, and the type that hand from a tab on the frame like the one shown in Figure 165. You can use either type for your trike.

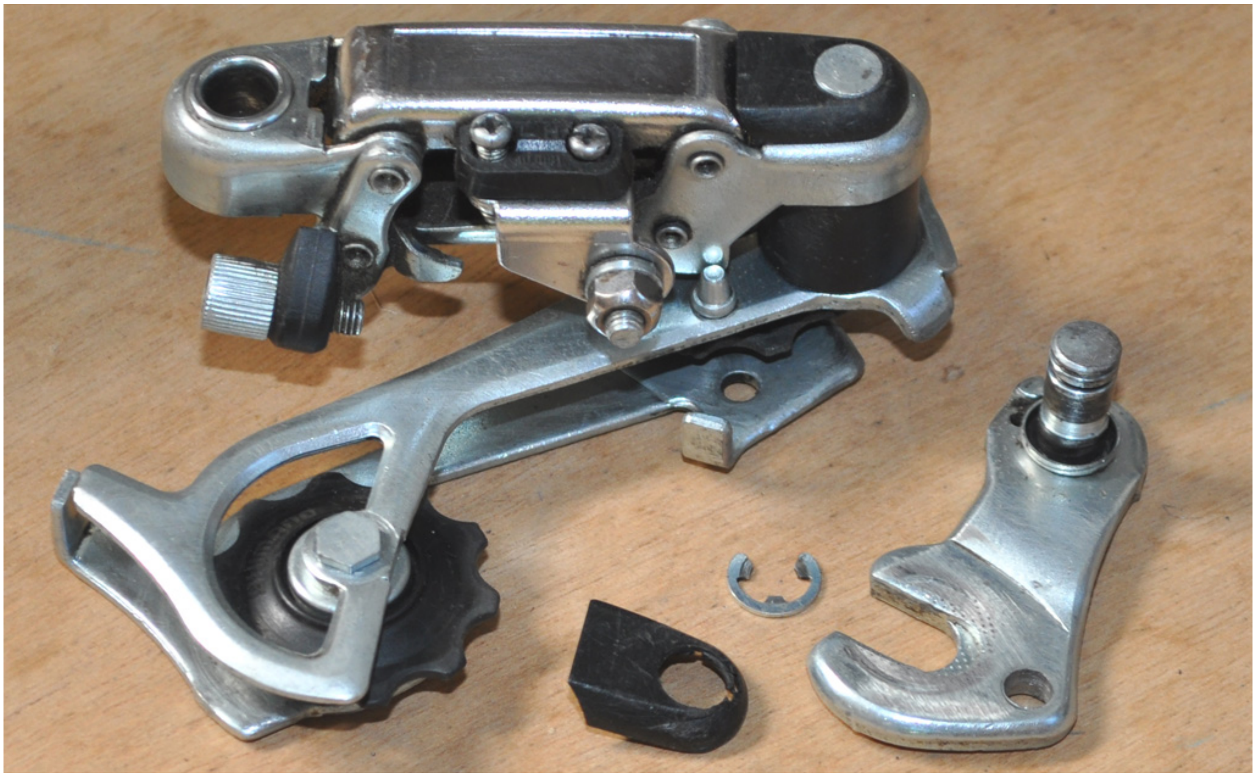
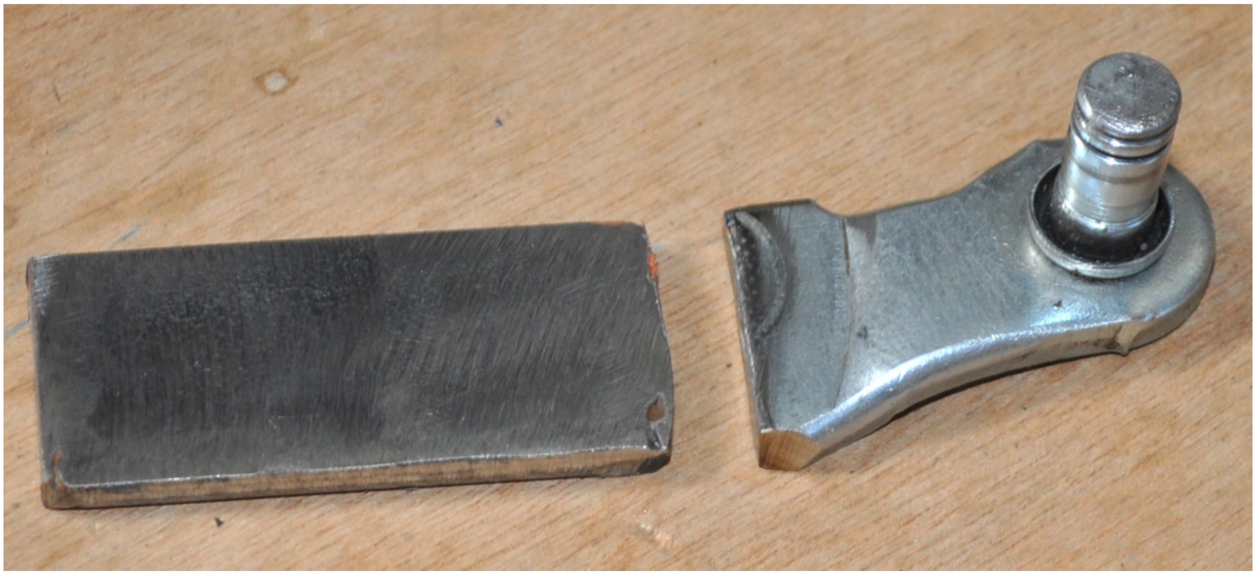


Figure 167 - Removal of the dropout mounting arm

If you intend to use the dropout mounting style of rear derailleur, then it will need a little modification since you no longer have a dropout to mount it to. Pop up the plastic cover and then remove the small C-ring to release the mounting arm as shown in Figure 167. Make sure that the mounting arm is made of steel because you will be welding another part to it.

Builders Tip



To modify the rear derailleur body to fit on an arm mounted to the frame tubing, hack off the slotted area and find of a bit of 1/8 or thicker flat bar to weld onto it to create an extension. Figure 168 shows the small 2.5 inch long piece of flat bar I used for this simple modification. Of course, the derailleur needs to be made of steel if this is to work properly.

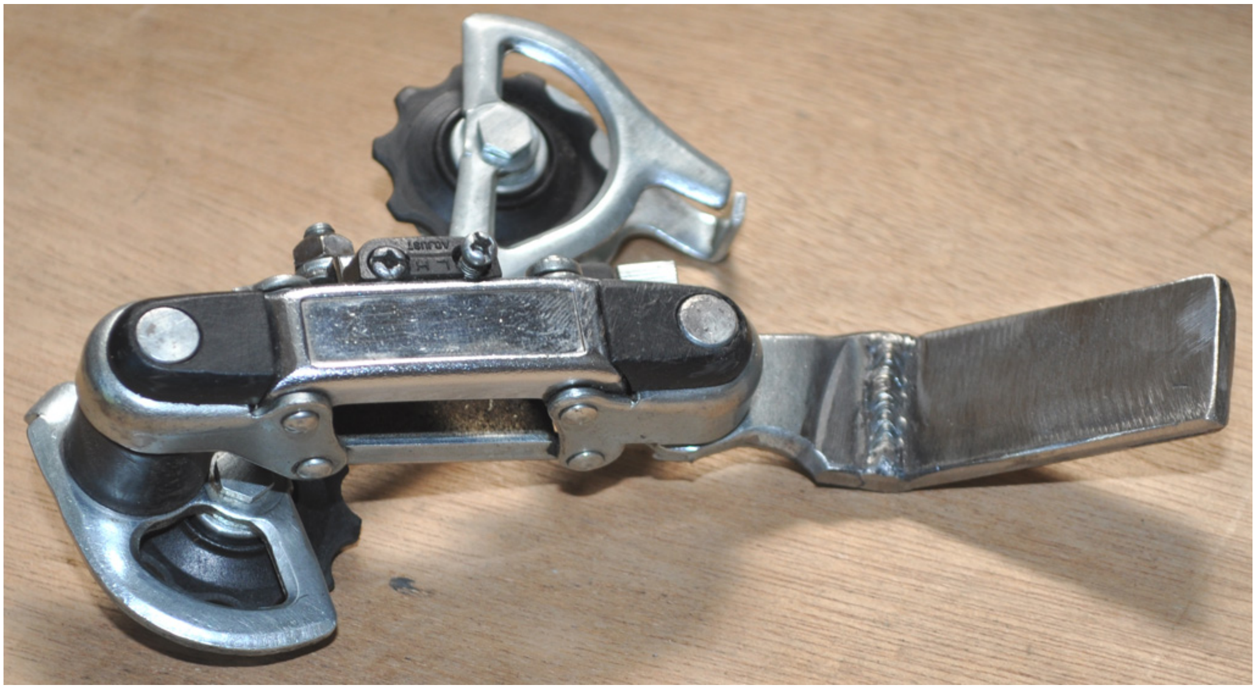


Figure 169 - Welding the derailleur arm

The new derailleur mounting arm is welded to the cut area as shown in Figure 169 at a slight angle so that it can connect with the nearest frame tube. Your derailleur may differ, so use whatever method and materials you can find to position the derailleur over the rear freewheel as it is shown in Figure 165.

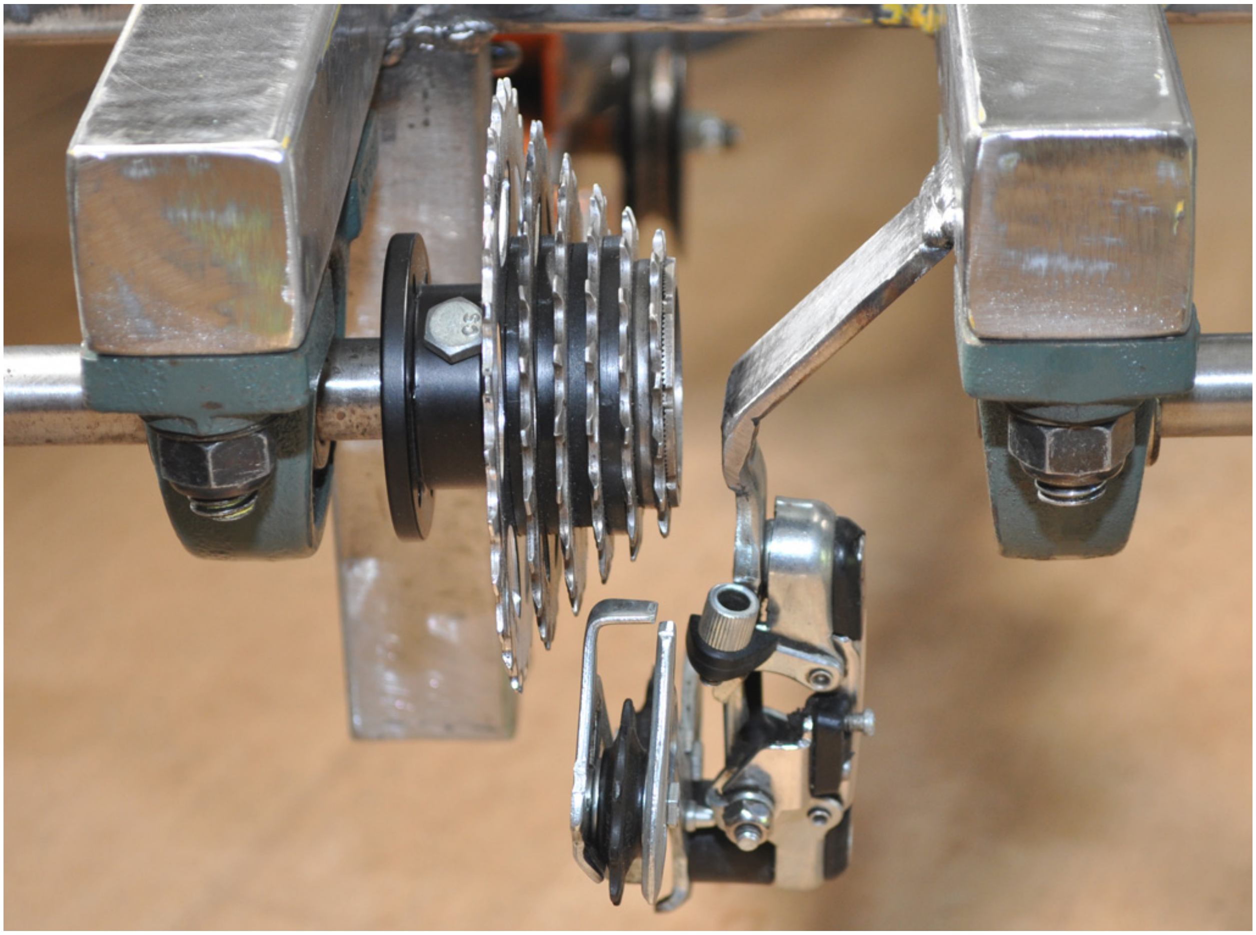


Figure 170 - Installing the modified derailleur

The modified rear derailleur arm is shown welded to the frame tubing in Figure 170. Now, the derailleur is sitting in a position next to the freewheel cluster exactly the way it was intended. If you need to see an example of proper rear derailleur positioning, take a look at a regular upright bicycle for measurements.

CHAIN AND IDLER PULLEY

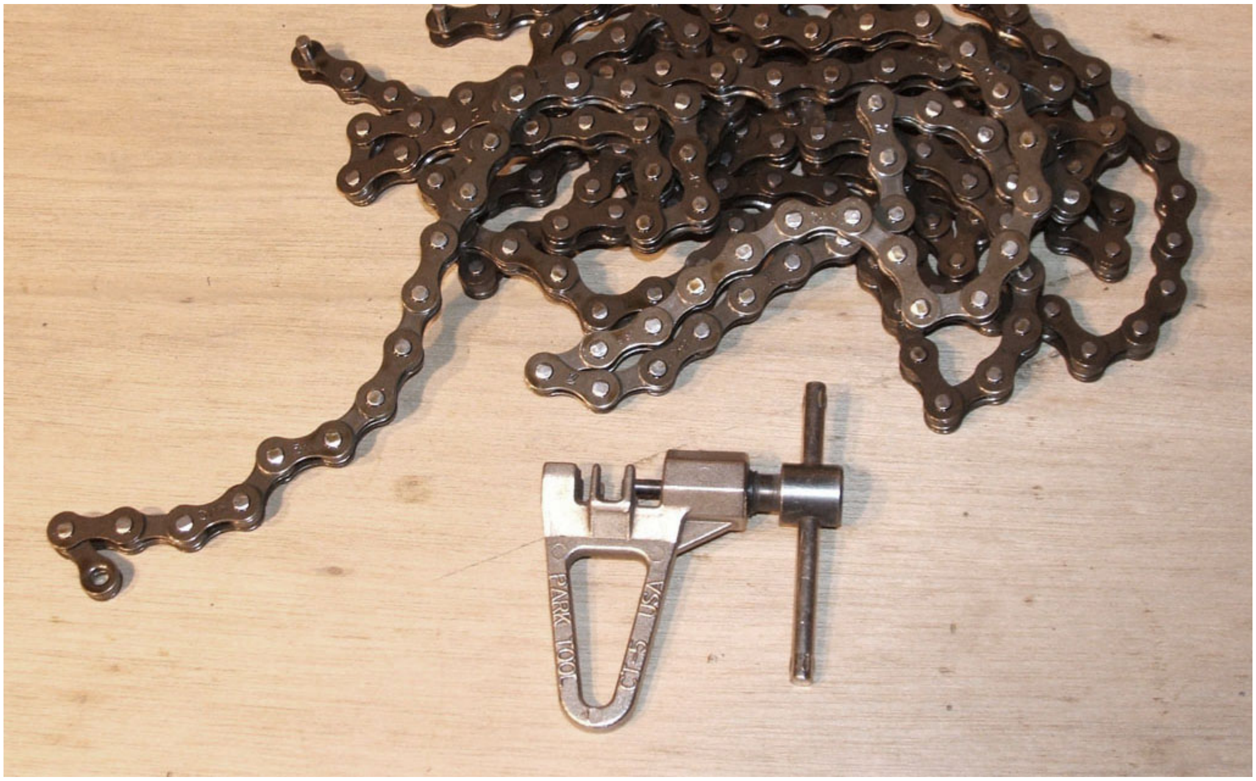


Figure 171 - Making up a new long chain

The Aurora Trike is so reclined that you will need almost twice the length of bicycle chain that you would normally require on an upright bicycle. Shown in Figure 171 is a wad of chain consisting of two new lengths of standard derailleur bicycle chain and an inexpensive tool that makes joining chains so much easier than the smack it with a hammer and punch system. Install your chain on the trike and don't worry if the chain seems a bit too long because you can adjust it after the guide pulley has been installed in the next few steps.

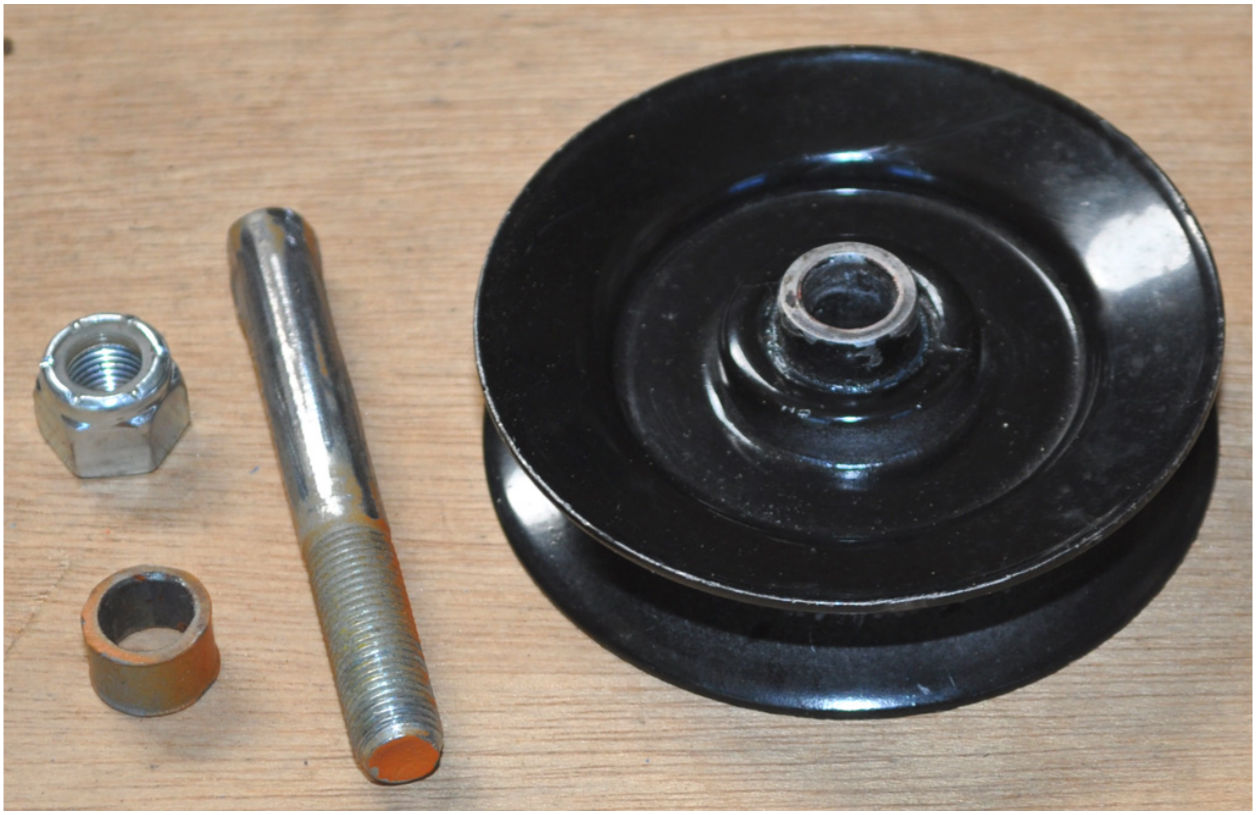


Figure 172 - Choosing a drive chain idler pulley

The best option for a guide pulley is a 2.75” to 3.5” diameter belt pulley made for a ½ inch V-belt as shown in Figure 172. This pulley will come with a decent bearing in the center and will allow the chain to sit nicely in the groove, making no sound whatsoever as you pedal.

Nylon or steel will work fine, but you should definitely avoid using any guide pulley with a diameter less than 2.75 inches, and don’t even try to use a rubber skate blade or skateboard wheel for this as they will not last very long and are made of material that is much too soft for the purpose. These half inch v-belt idler pulleys can be purchased at most hardware stores or any shop that services lawn and garden equipment. You will also need a bolt that fits the center of the pulley and sticks out about 2 inches on one side. Trim the head off the bolt as shown in Figure 172.

✓ Builders Tip

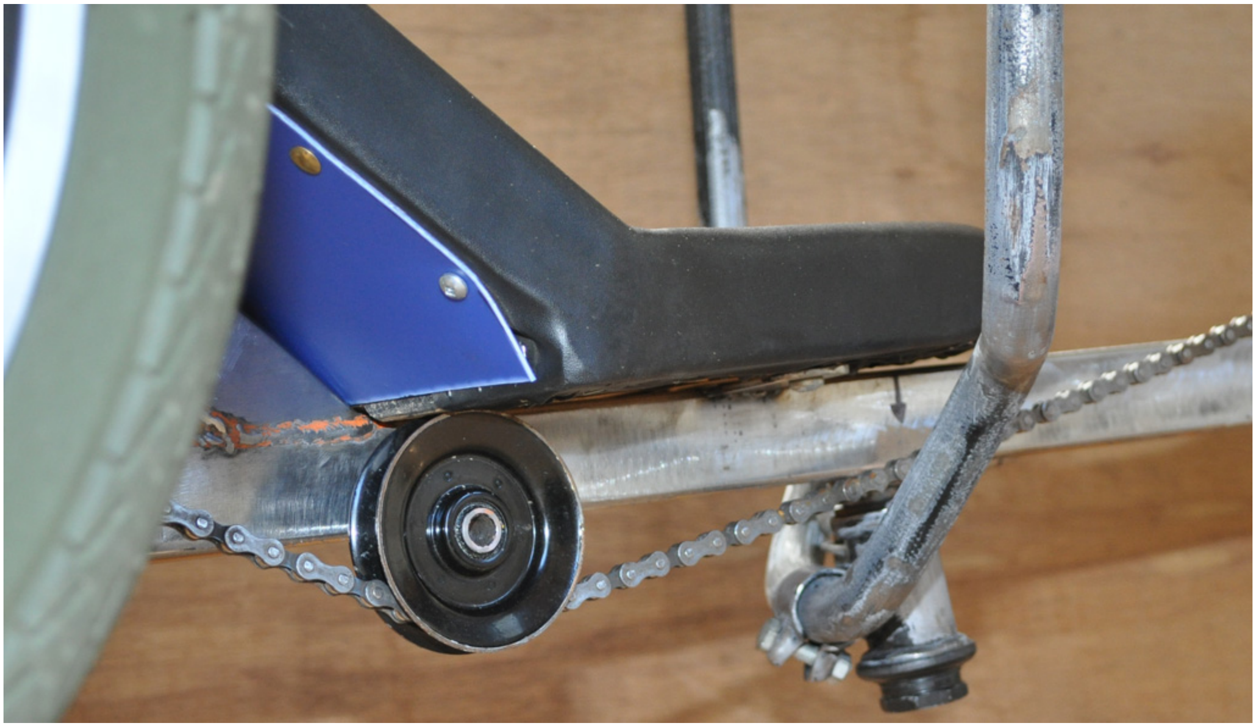


Figure 173 - Finding the optimal position for the drive chain idler pulley

The goal is to bend the chain as little as possible and at the same time ensure that it will not strike the underside of the seat or the handlebar tubing as the handle bars are moved from side to side. Placing the idler pulley just under the seat near the back corner as shown in Figure 173 will probably be your best bet, but experiment to see how things work with your own handlebars. Also, make sure that the pulley will not rub on the underside of the seat.

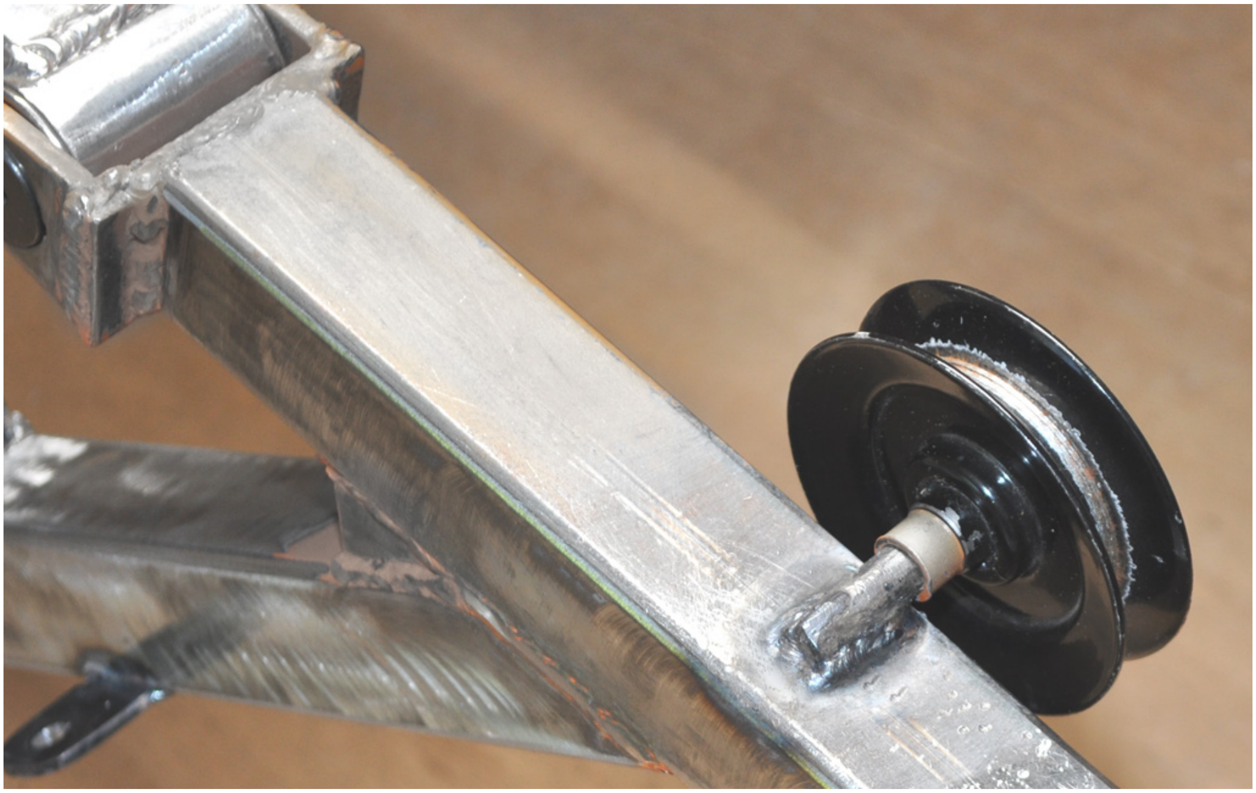


Figure 174 - Installing the idler pulley mounting bolt

The idler pulley mounting bolt will be welded to the frame as shown in Figure 174 so it can be positioned about ¾ inch away from the side of the frame with a spacer as shown here. The idea is to have the pulley in a place that aligns the chain along the frame when it is placed on the largest crankset chain ring and on the middle rear freewheel chain ring. Installing the pulley about ¾ inch away from the side of the main boom tube will be good enough, and you can use a bit of tubing or washers as spacers.

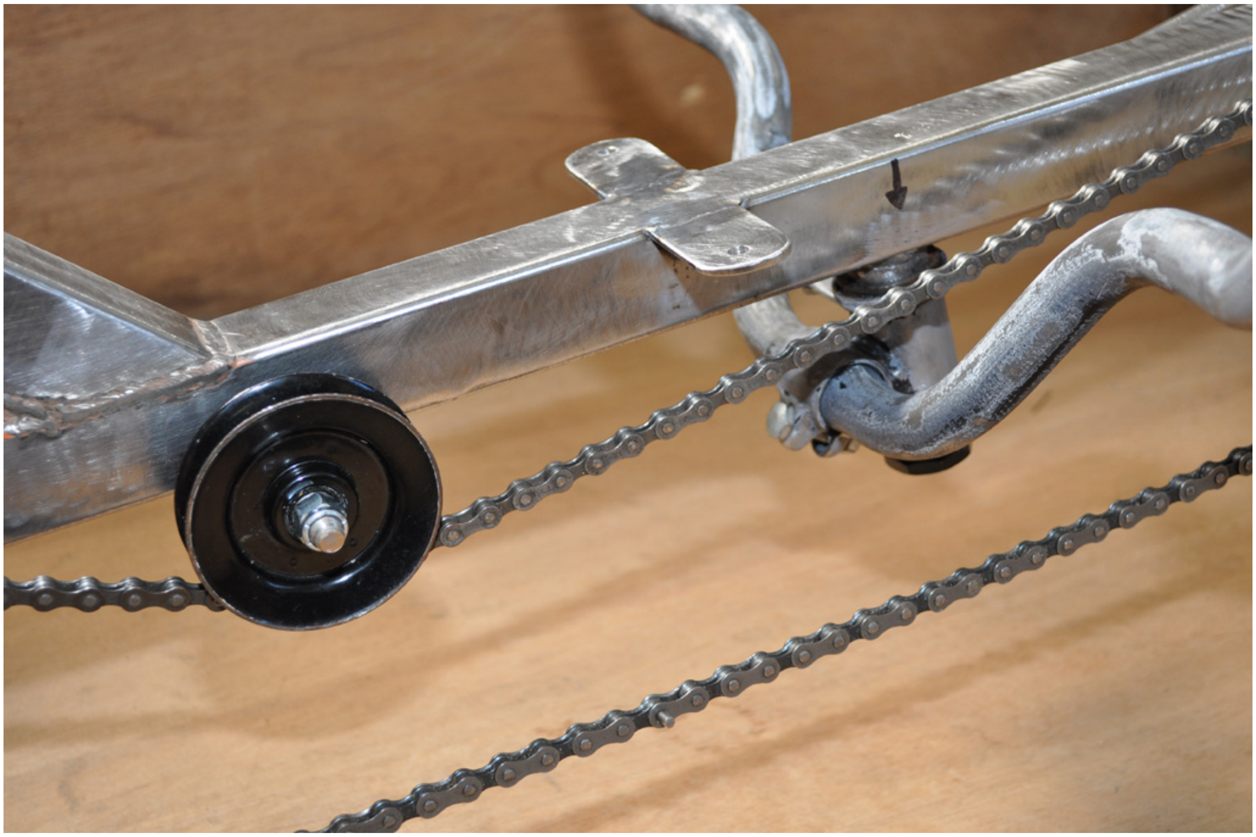


Figure 175 - The chain guide pulley installed

Install your guide pulley on the bolt and then place the drive side of the chain (top side) under the pulley as shown in Figure 175. The chain will travel from the top of the rear freewheel, under the guide pulley, over the handlebar tubing, and then into the top of the crankset chain ring. This is the only part of the chain that does any work, so it needs an unobstructed line, clear of any interference from other parts of your trike.

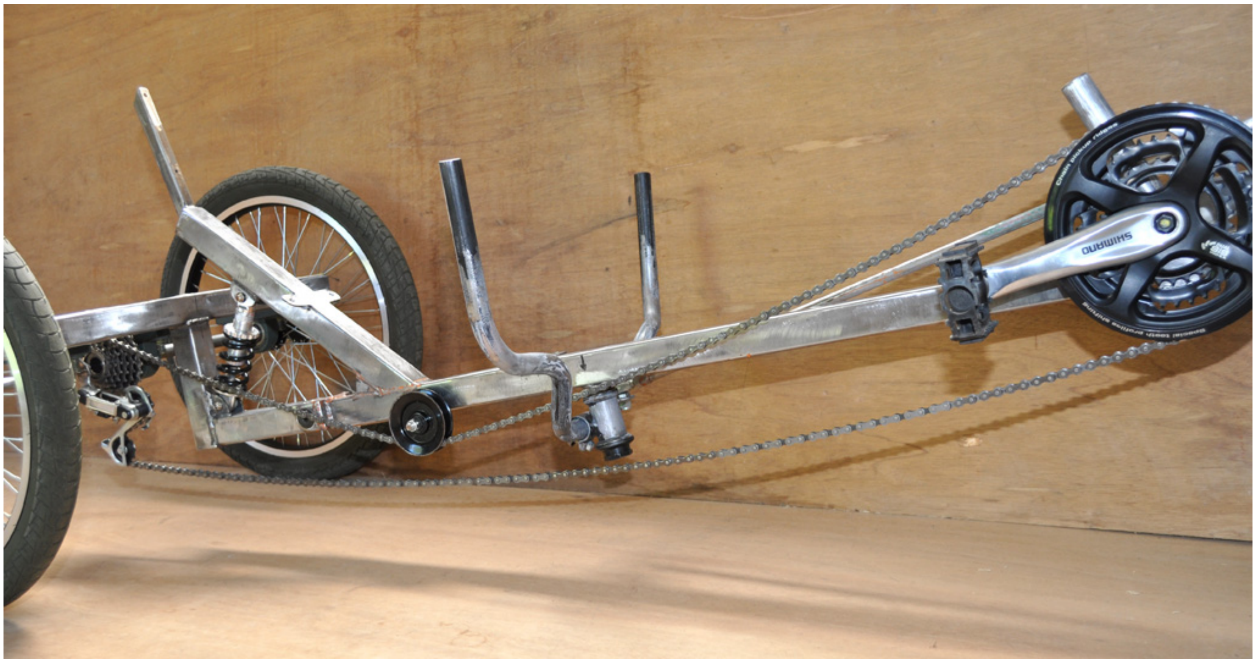


Figure 176 - Setting up the optimal chain length

Place your chain on the largest front chain ring and then on the middle rear freewheel chain ring. You can now adjust the length of your chain using the chain link tool until it looks similar to what is shown in Figure 176. The chain should sag just under the guide pulley, and the rear derailleur should sit with both idler wheels on top of one another. Now we will make a lower chain guide tube to pick up that slack so the chain is not flopping around on the ground over bumps.

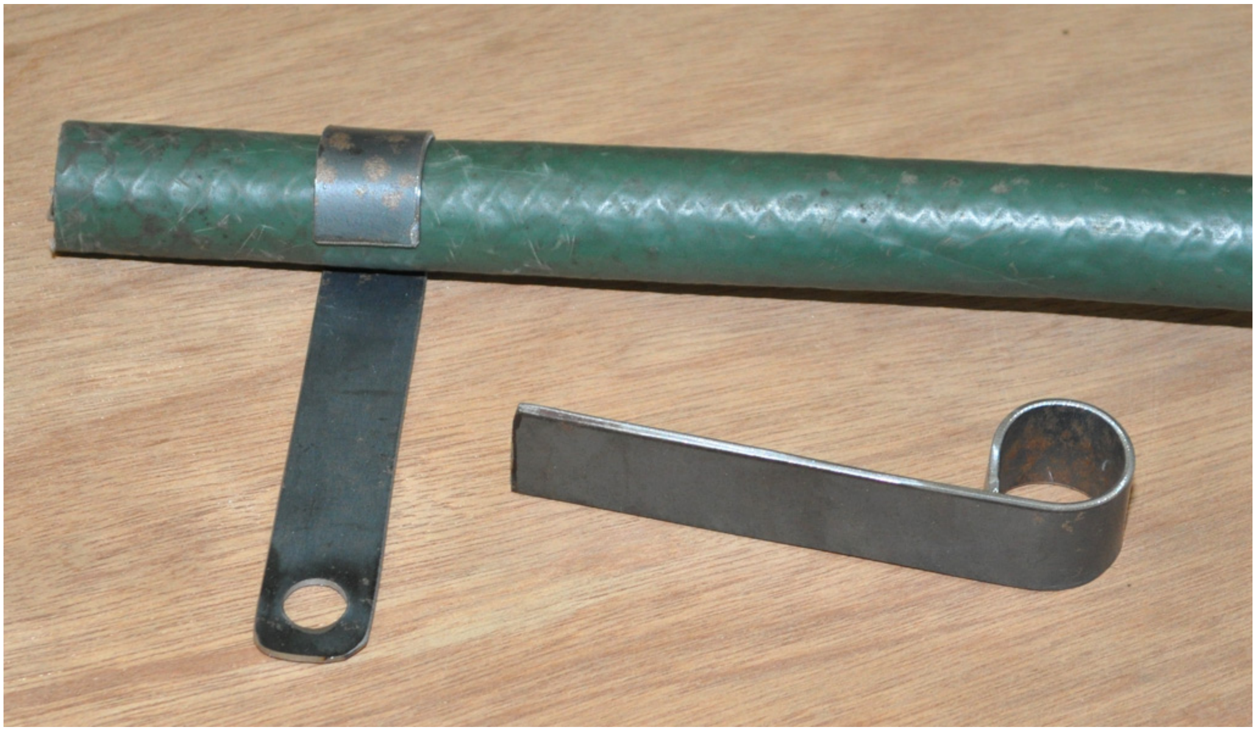


Figure 177 - The return chain guide is just a piece of garden hose

The return side of the chain is now left flopping in the breeze and certainly does not look very professional left like this, so a simply chain pickup system can be made from an 18 to 10 inch length of standard garden hose. Since the return chain is never under any tension, it will just slip through the hose without any friction, keeping it from bouncing around or collecting dirt as you bounce over rough terrain. 18 inches of garden hose and a pair of hooks made by bending some thin 1 inch strips of 16 gage sheet metal will do the trick. The simple hooks shown in Figure 177 are made be bending a loop at the end of a 7 inch long strip so they end up approximately 4 inches long. One is welded to the frame and the other will hang from the idler pulley mounting bolt.

Builders Tip

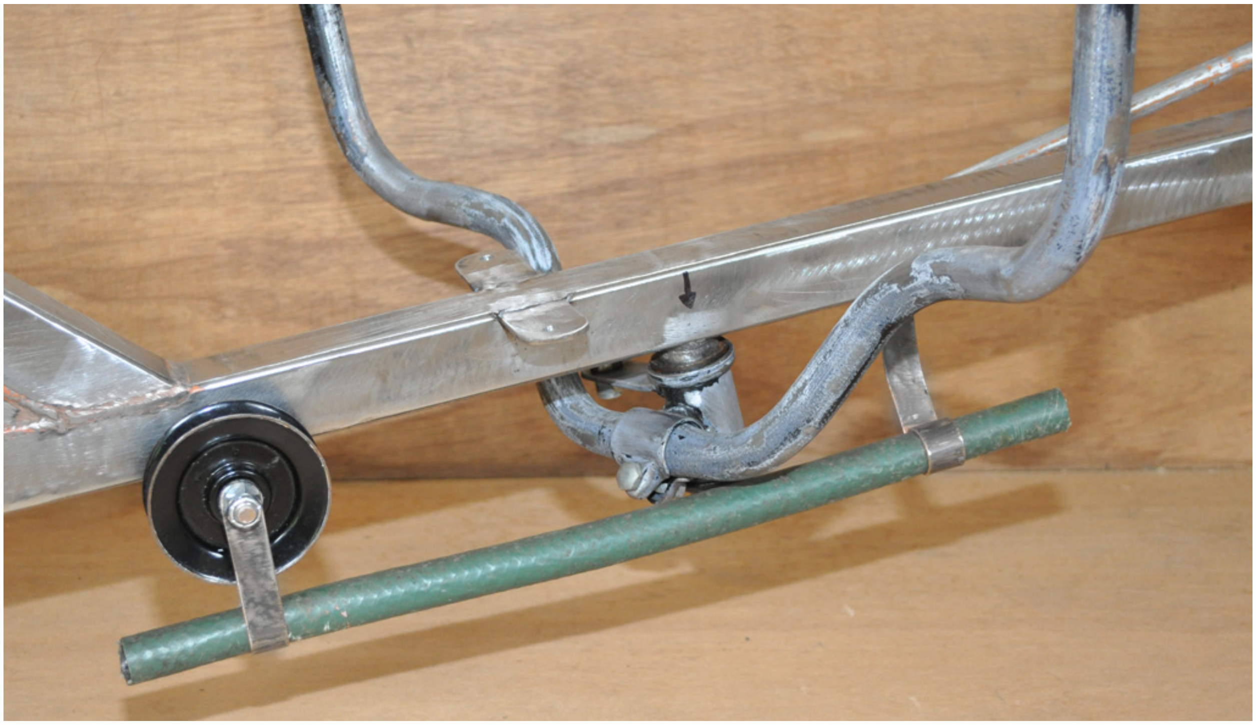


Figure 178 - The return chain idler tube installed on the frame

Figure 178 shows how the two hooks hold the return chain pickup tube just beneath the handle bars, allowing the slack return chain to be kept from bouncing around during rough riding. If the rubber hose happens to touch the handlebars slightly, it's not much of a concern since there is no tension in the chain.

REAR DISC BRAKES

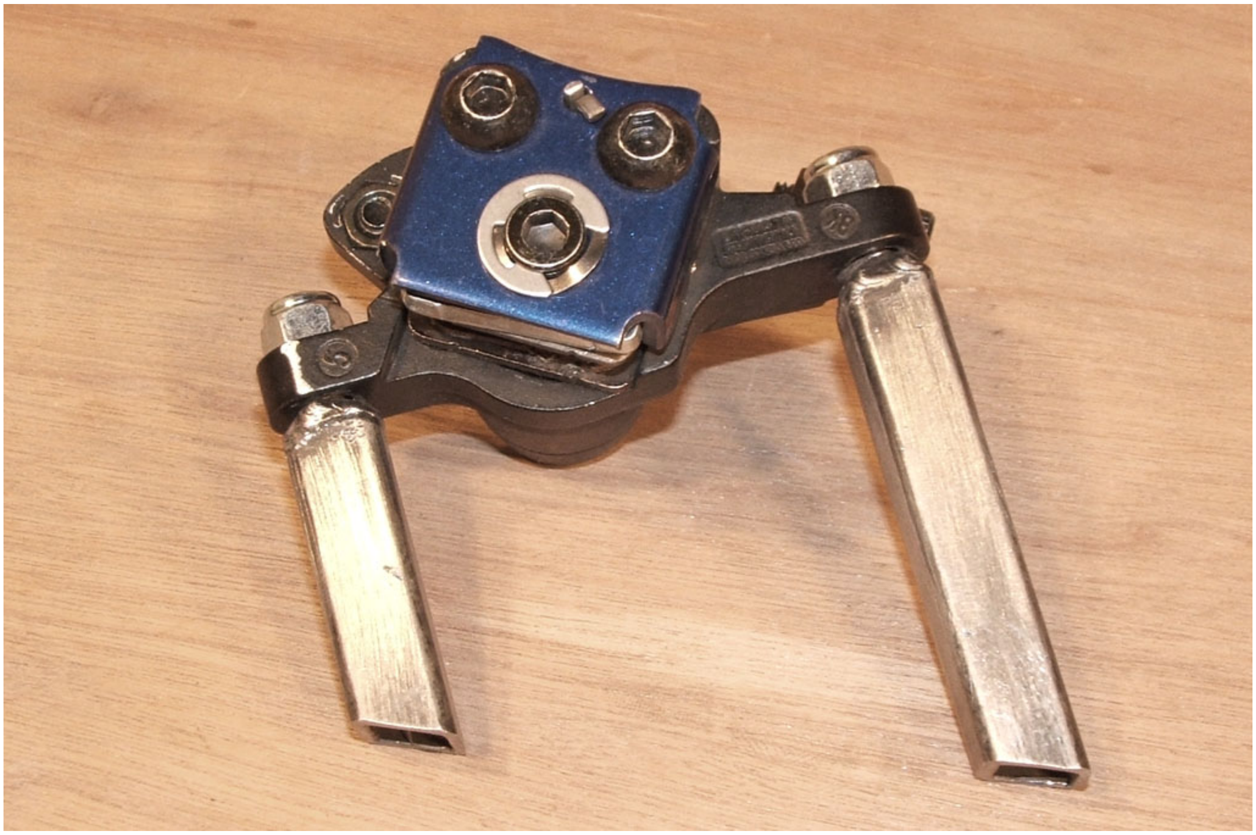


Figure 179 - Disc brake mounting hardware

There are many styles and types of disc brakes available. I will be installing a cable pull disc brake set as shown in Photo 179. This type of brake is simple and inexpensive as compared to the hydraulic version and works very well, much better than any caliper pull brake. Since the mounting system needed for your disc brake could be radically different than mine, there is no point in giving out dimensions for the two small steel mounting tubes I am using to secure the hardware to the frame. The goal is to simply place the brake hardware over the disc so that both pads grip the disc in the appropriate place.

The two small ¾ inch square tubes shown in Photo 179 will form mounting pegs that will allow the disc brake hardware to be placed over the disc brake rotor at the appropriate position. These mounting pegs are welded to the frame tube directly under the seat for the drive side axle. To determine what type of mounting hardware you need for your disc brakes, simply hold them in place on the rotor and measure the length of tubing or angle iron you will need to secure them there. The two fine thread bolts are welded directly to the end of each of the mounting pegs in order to fasten the disc brake hardware. The mounting pegs are then welded to the frame tubing under the seat. Since this is guesswork, I made the mounting pegs a bit longer than necessary and then ground them down as needed a little bit at a time.

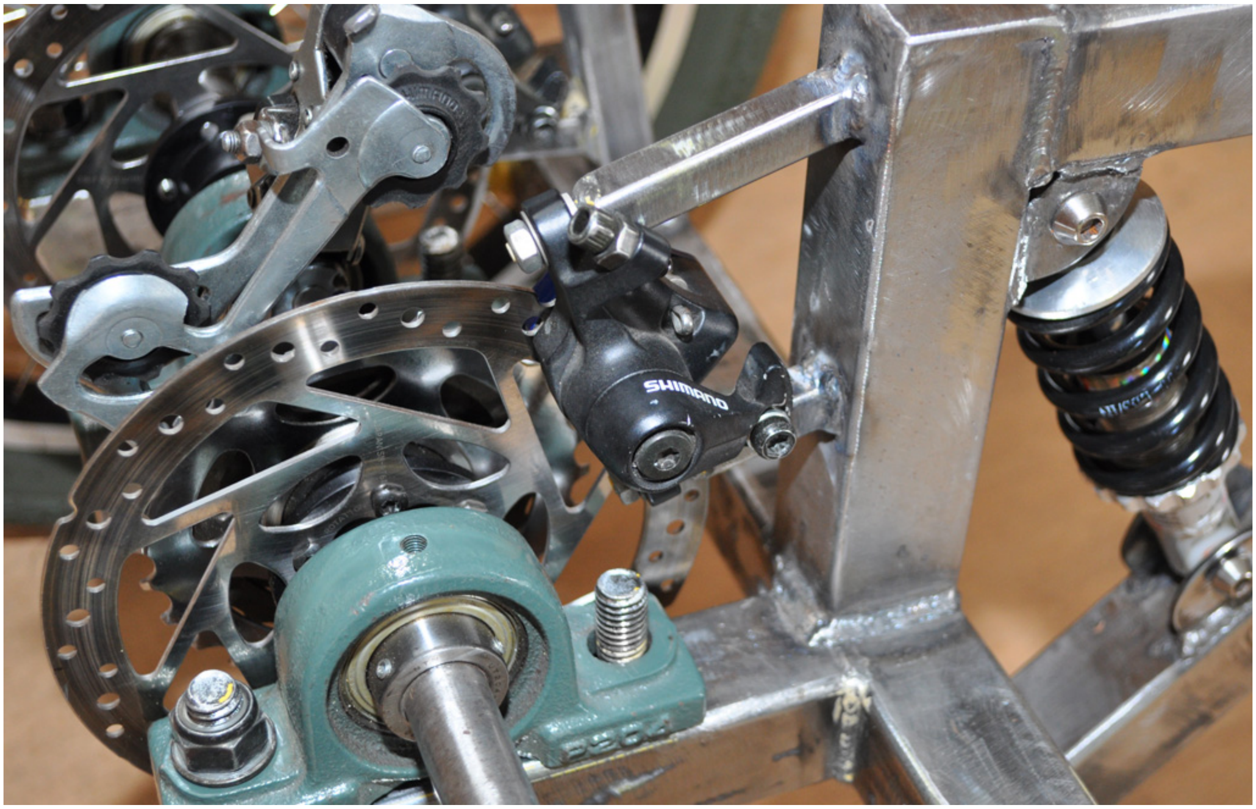


Figure 180 - disc brake installed

Figure 180 shows one of the disc brakes installed after welding the two mounting pegs to the frame tubing. To get the disc brake in the exact position, the two pegs are first fastened securely to the brake hardware, and then it is placed over the disc and engaged. By engaging the brake, the two pads squeeze the disc and place the brake perfectly centered. To hold the brake lever in place, I used a plastic tie wrap. The brake hardware is then wrapped in a bit of tape to protect it from weld spatter as the two mounting pegs are tack welded to the frame. Once the two pegs have a few decent tack welds, release the brake lever and spin the wheel to make sure the disc is not rubbing.

Bicycle disc brakes are self centering to a point, so a small amount of rubbing may be present between one or both brake pads and the disc when the brake is relaxed. This small amount of rubbing should not introduce any noticeable friction into the wheel as it spins. If there is excessive friction or rubbing sounds, your disc brake hardware is probably not centered properly.

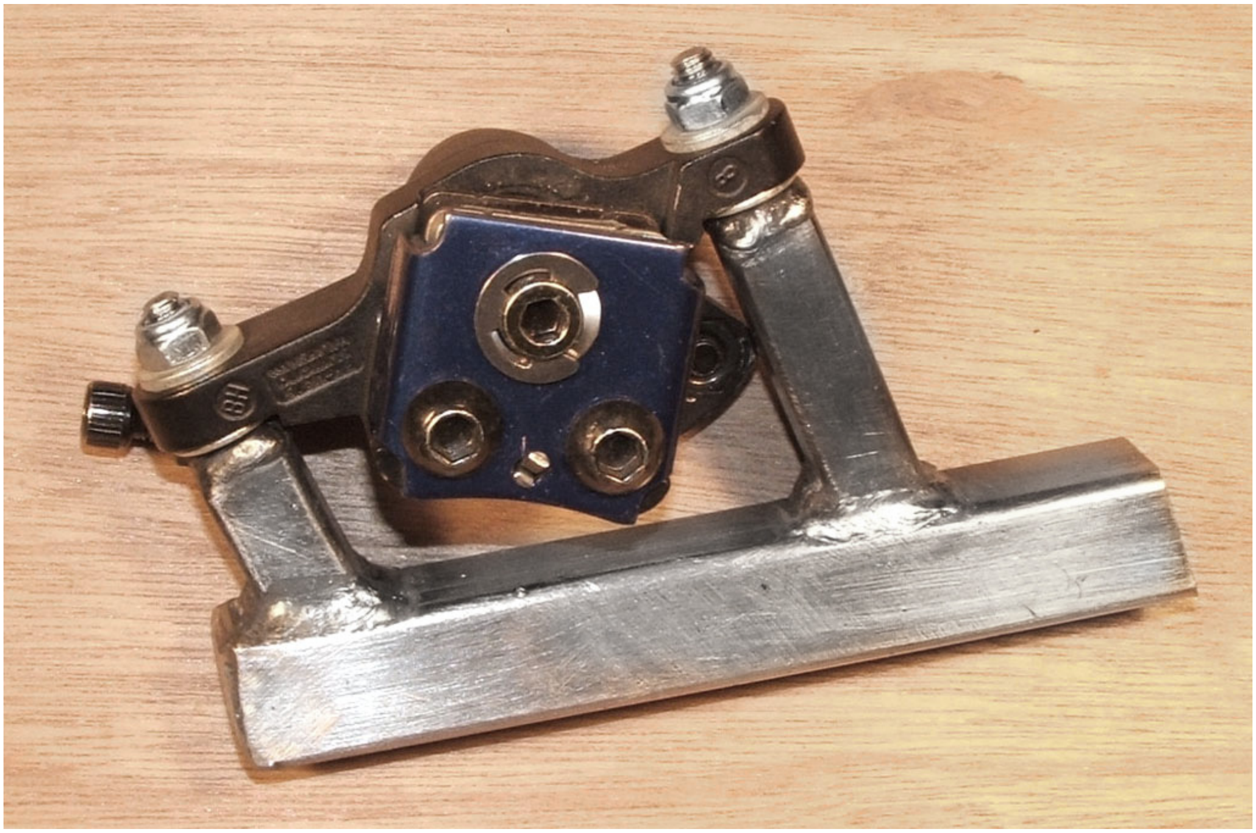


Figure 181 - Disc mounting peg for the other side

On the non-drive side axle, there is no frame tubing directly over the disc brake, so the disc brake hardware will have to be mounted to the rear of the frame instead. You may find another method of installing the brake hardware, but the simple mounting system shown in Figure 181 seems to work perfectly, and only requires a few more mounting pegs and slightly larger 1 inch square tube to allow it to be fastened to the rear of the frame. The lengths and angles of the tubes are all calculated by holding the brake in place where you want it to be affixed so that rough measurements can be made. Cut more tubing than you need at first, and then grind away the extra metal a little at a time until your disc brake hardware is mounted in the proper position.

Note: when creating your disc brake mounting hardware, pay attention to the position of the cable entry point so that your cables will have a clean line to the brake hardware. Also note that certain mounting positions will require you to slide the axle out of the pillow block bearings in order to remove or install the brake hardware. In the mounting system shown in Figure 182, I have to slide the axle out of the bearings before I can install or remove the brake hardware since it would be impossible to lift the bearings off the bolts.

✓ Builders Tip

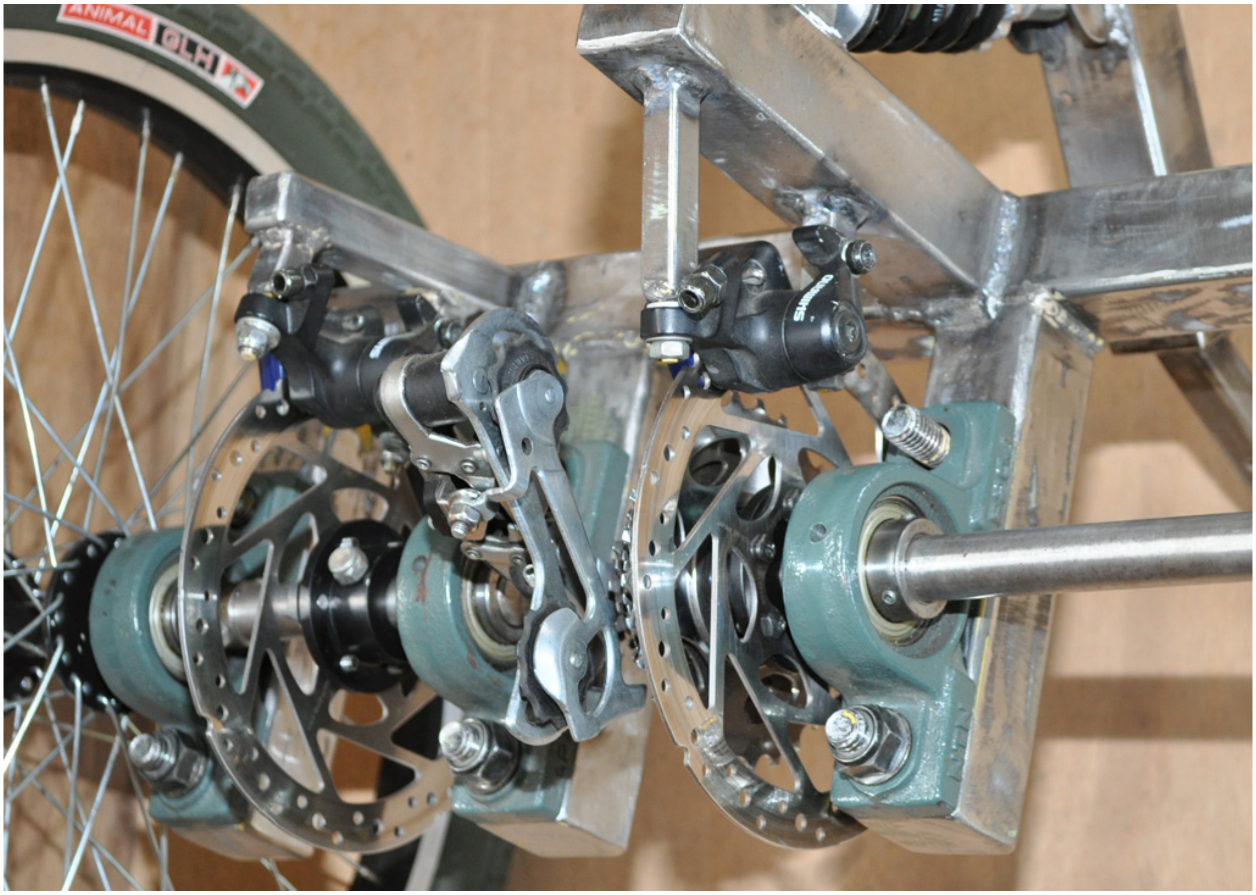


Figure 182 – Both rear disc brakes installed

Figure 182 shows all of the brake hardware installed on the frame. To see a clearer view of this hardware, refer ahead to Figure 194.

READY FOR A TEST RIDE

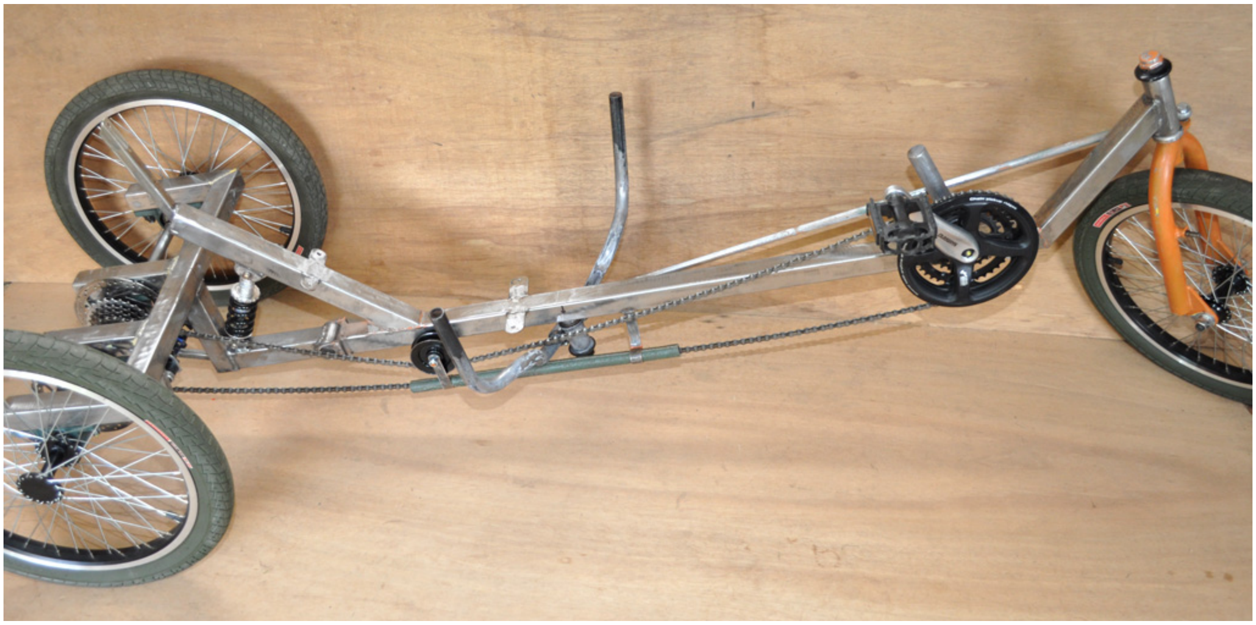


Figure 183 - The trike is ready for a test ride

At this point, you can install one of the brakes and take your new trike out for a test ride. You can get away without gear shifters by adjusting the "min" and "max" set screws on the derailleurs in order to place them in some middle range gear. I highly recommended you have at least one brake installed for your first test ride though - this advice comes from personal experiences!

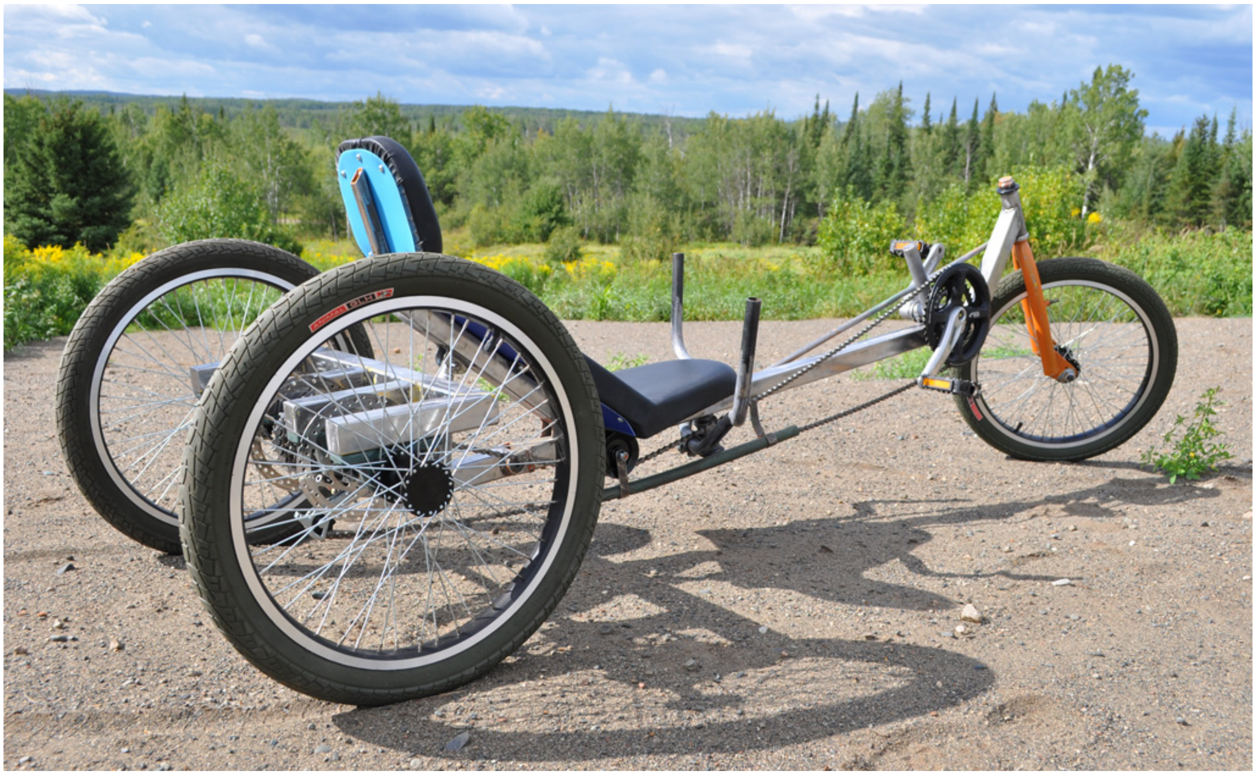


Figure 184 - The unpainted Aurora Delta Trike

Your initial test ride is the perfect time to figure out where you like your handlebars and to work out any transmission or steering quirks. Take your trike around some tight corners and over some rough terrain to get a good feel for its handling characteristics. You may want to adjust the tension in your suspension spring, which can be done by turning the larger ring that sites over the spring. To stiffen your ride, crank the ring in the clockwise rotation to compress the spring.

THE FRONT BRAKES

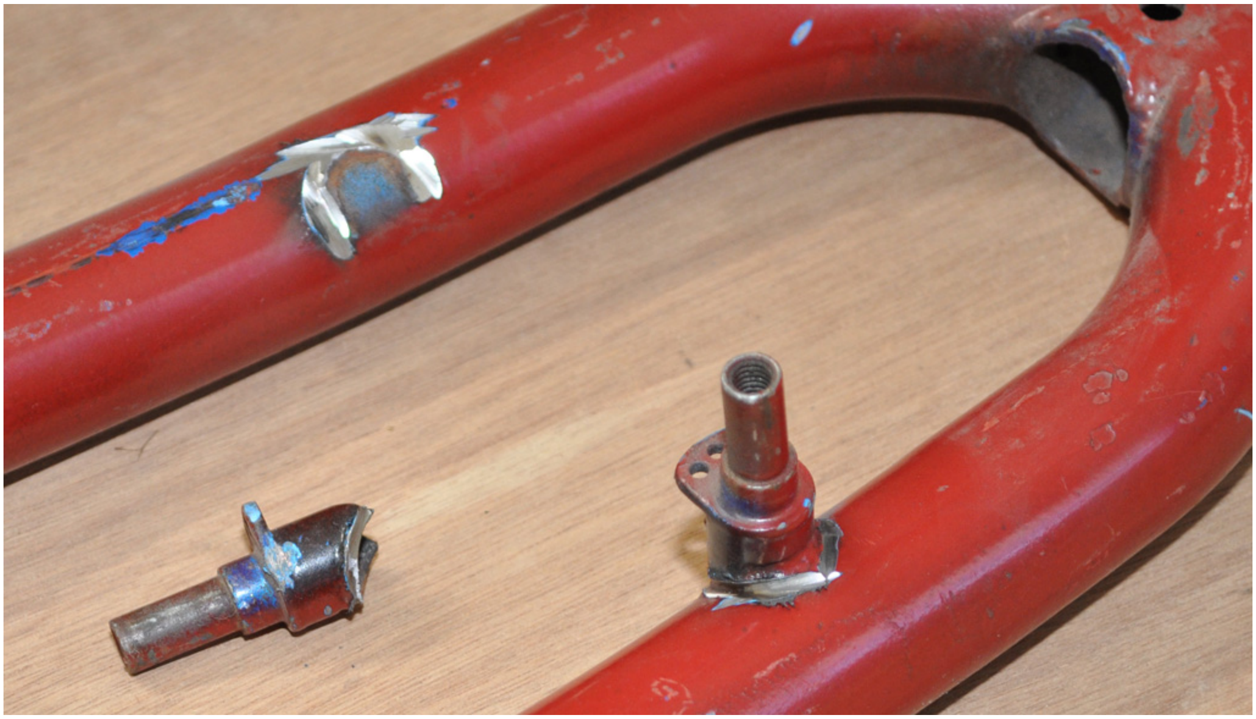


Figure 185 - Removing brake studs for transplant to another fork set

Although Aurora Trike has dual rear disc brakes, you can still add a front brake for ultimate stopping power if you intend to haul heavy cargo or add a motor. If your chosen front forks already have brake studs installed then you are all set, but often 20 inch forks do not have brake studs as the small bike they came from might have had a single rear coaster brake or a bolt on side pull brake. For optimal front braking power, cantilevered brakes are best, and you can easily transfer the brake studs from one set of forks to another.

To remove brake studs, use a hacksaw or zip disc to carefully cut along the weld until the part is freed as shown in Figure 185. There will be some surface damage to the fork legs, but if you plan to reuse these forks, a little welding and grinding repair work can easily fix them later.

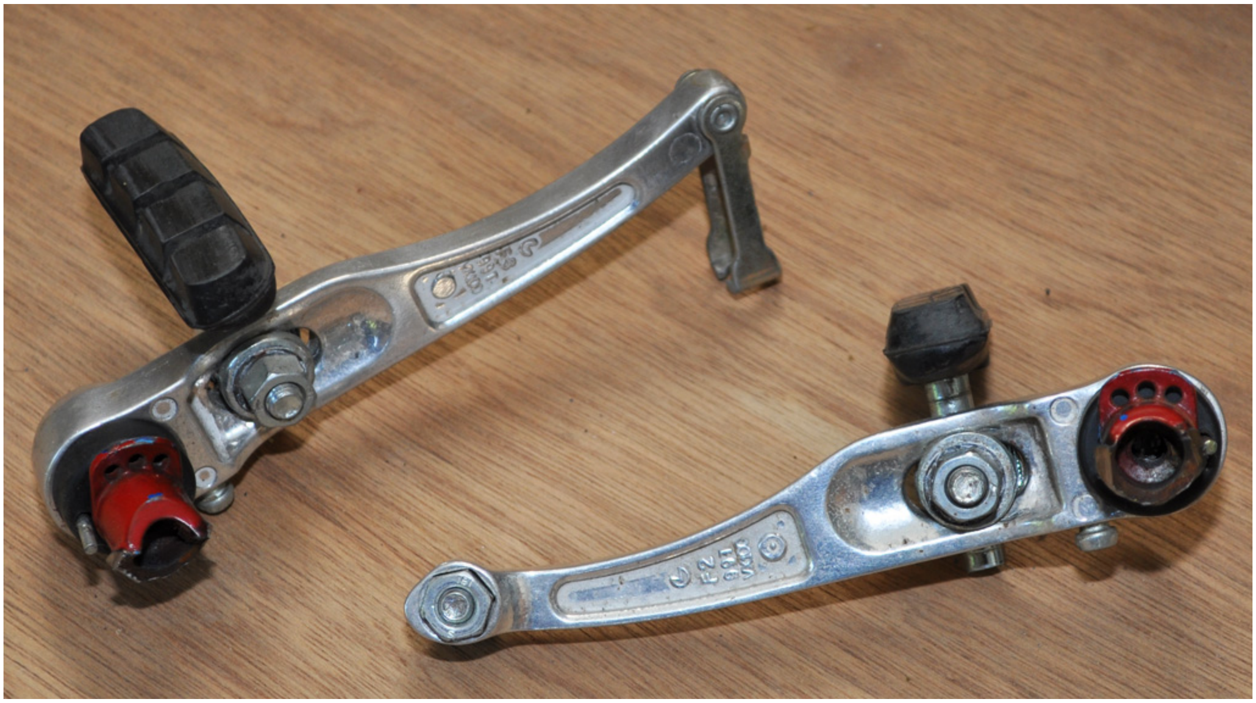


Figure 186 - Install the brake studs into the brake levers

To align the brake studs to the new set of forks, install them on the brake arms as shown in Figure 186, just as they were when the original brakes were installed and functioning. You will be using the brake pads against the rim to calculate the placement of the brake studs on your 20 inch forks. Do not load the spring into the hole though, or you will not be able to turn the stud.

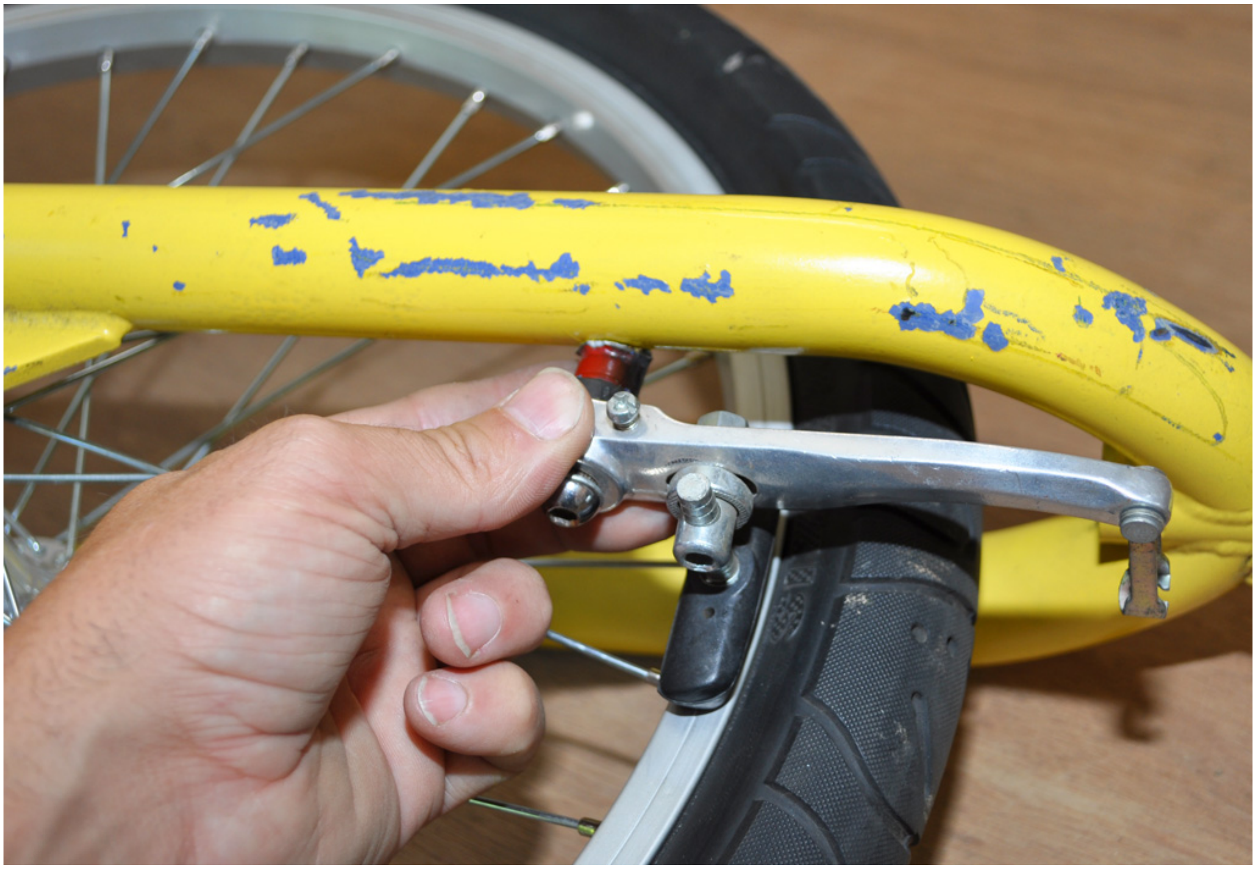


Figure 187 - Aligning the brake studs onto the 20 inch forks

Using the brake pads as an alignment guide, place the stud on the fork leg as shown in Figure 187 so that the pad strikes the rim face in the correct position. The brake stud will be standing off of the fork leg at 90 degrees and pointing directly forward when aligned properly.

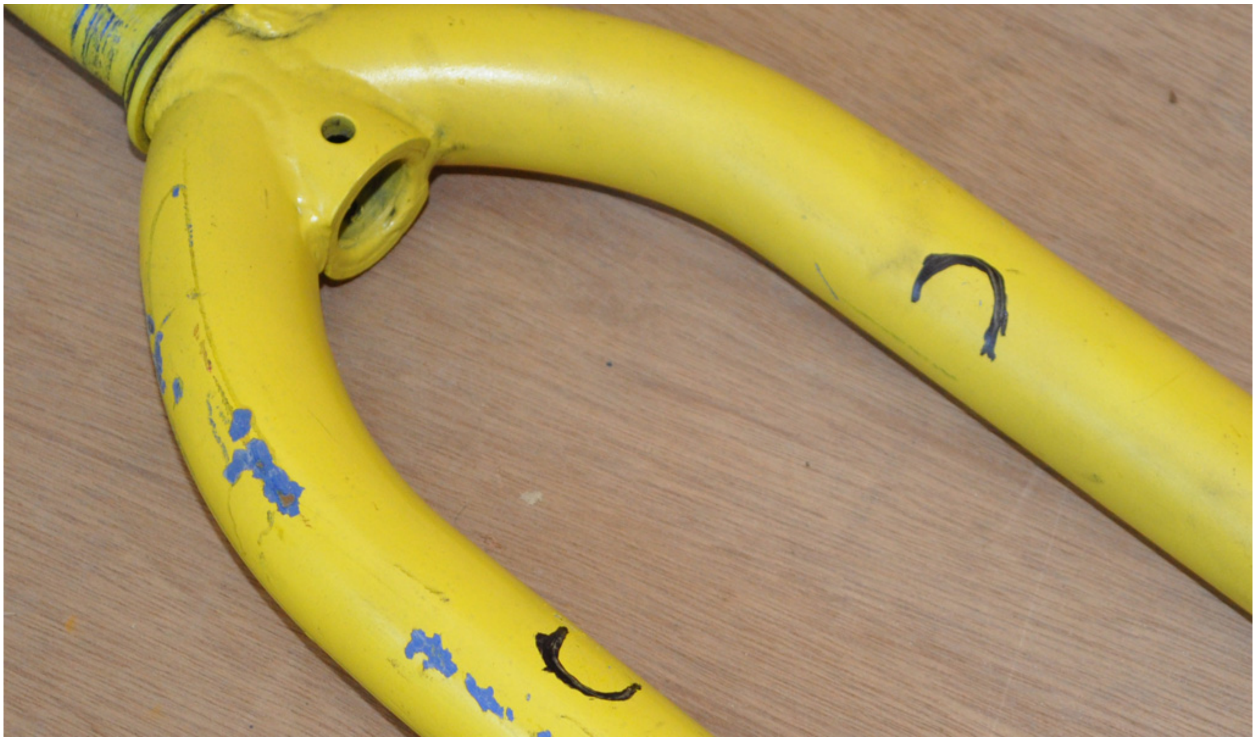


Figure 188 - Marking the optimal placement for the brake studs

Mark the placement of both brake studs as shown in Figure 188, and then verify that they are both at an equal distance down the fork leg. The marks are made once the paint has been removed, but for photo clarity, I have drawn them over the paint.

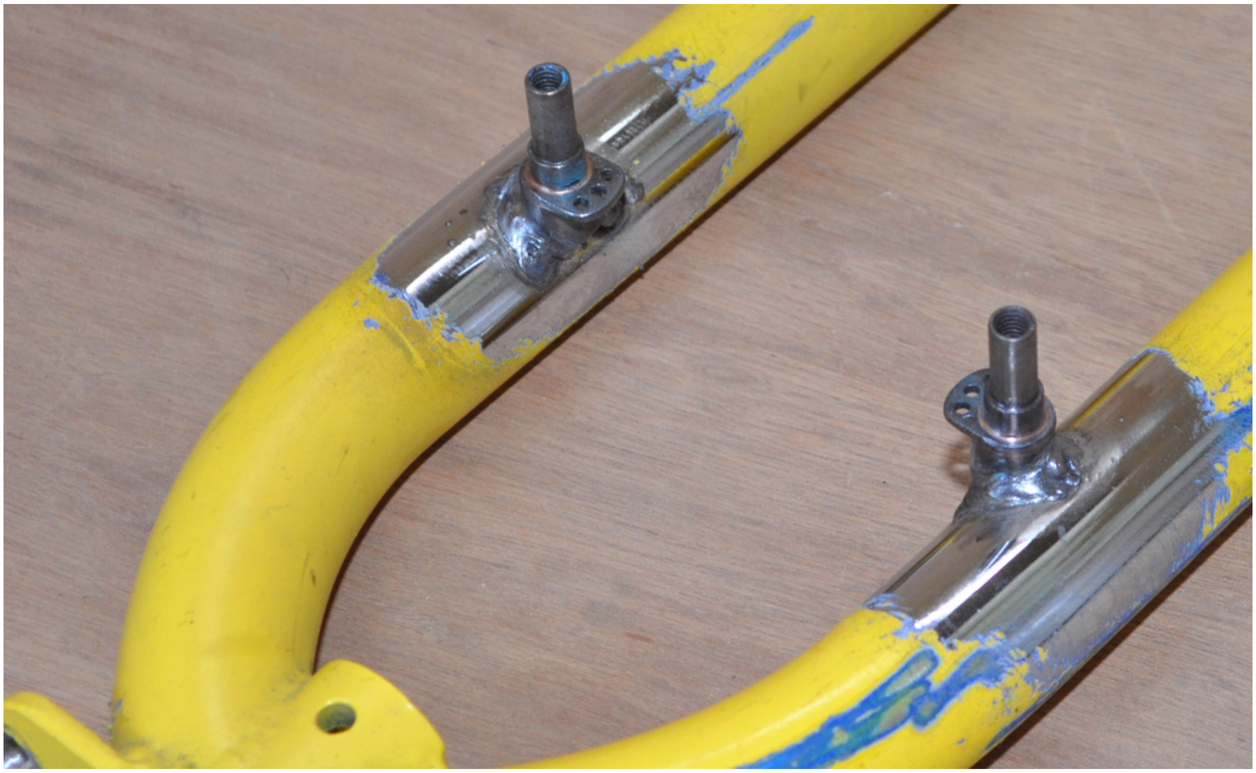


Figure 189 - Welding the brake studs to the fork legs

Weld the brake studs to the fork legs in the place you have marked as shown in Figure 189, making sure to weld all the way around the sides just as they were on the original fork legs. If you have made a slight alignment error, this can be corrected when you align the brake pads on the rim surface.

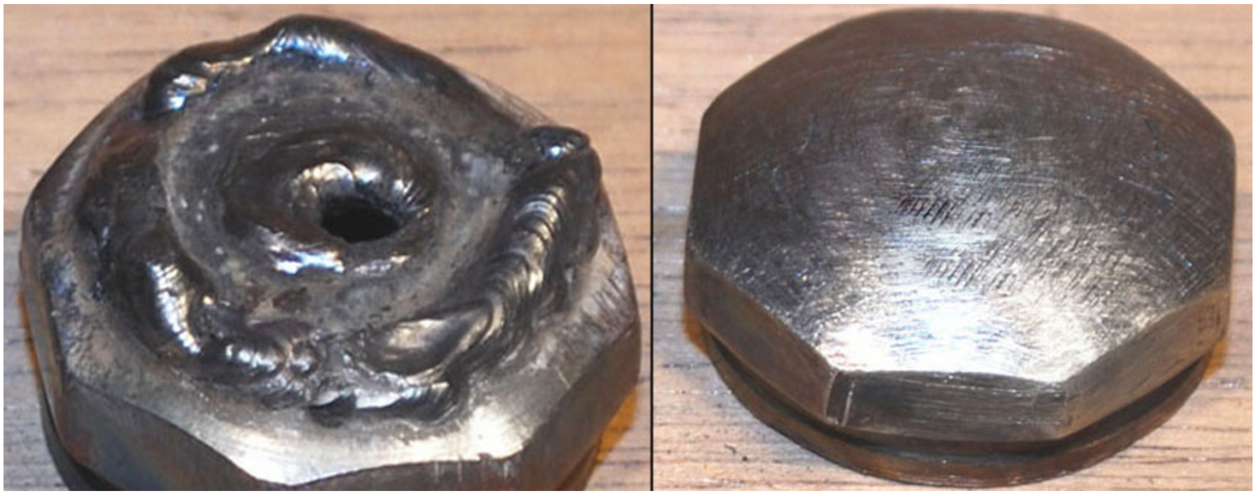


Figure 190 - Making a closed top fork cap

To close off the top fork hardware from the rain, a steel top fork nut can be made into a solid cap by welding a washer to the top and then filing in the hole. With a little careful welding and grinding, the completed part shown in Figure 190 looks like it was turned on a lathe.

PRIMING AND PAINTING

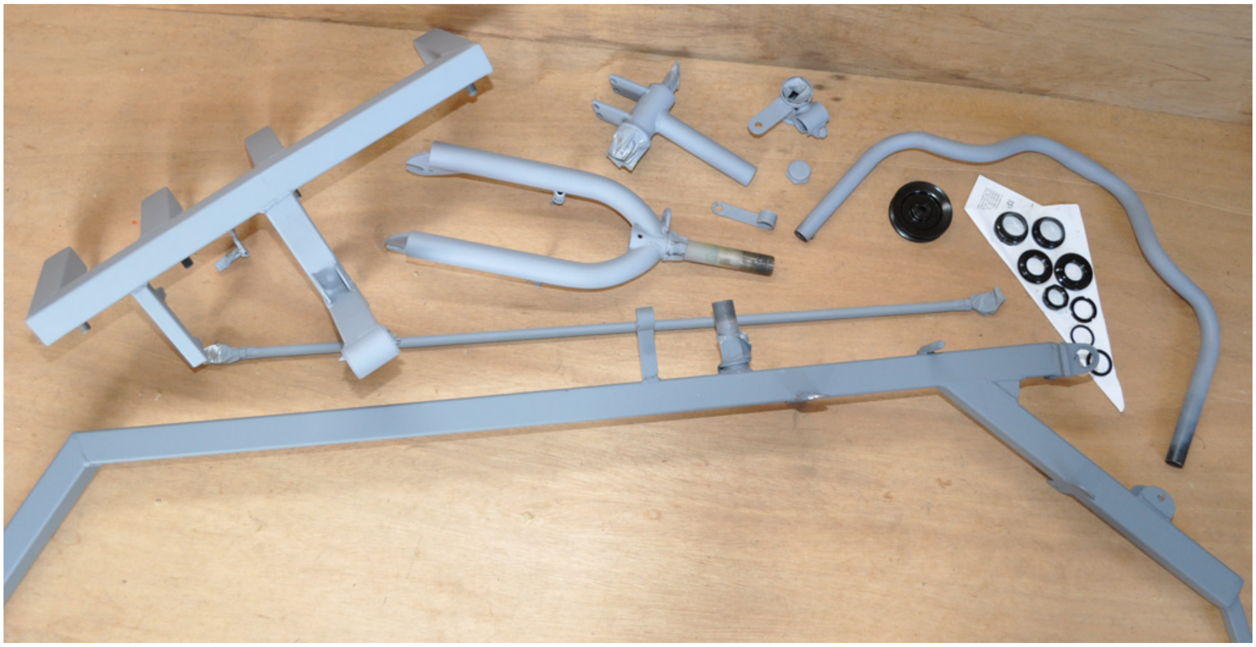


Figure 191 - Priming the frame before painting

A good coat of primer should always be applied and allowed to cure overnight before applying any paint. Follow the manufacturer’s directions, and you can really do a great paint job using department store spray paint cans. Figure 191 shows my Aurora frame patiently waiting to cure after having a fresh coat of metal primer applied.

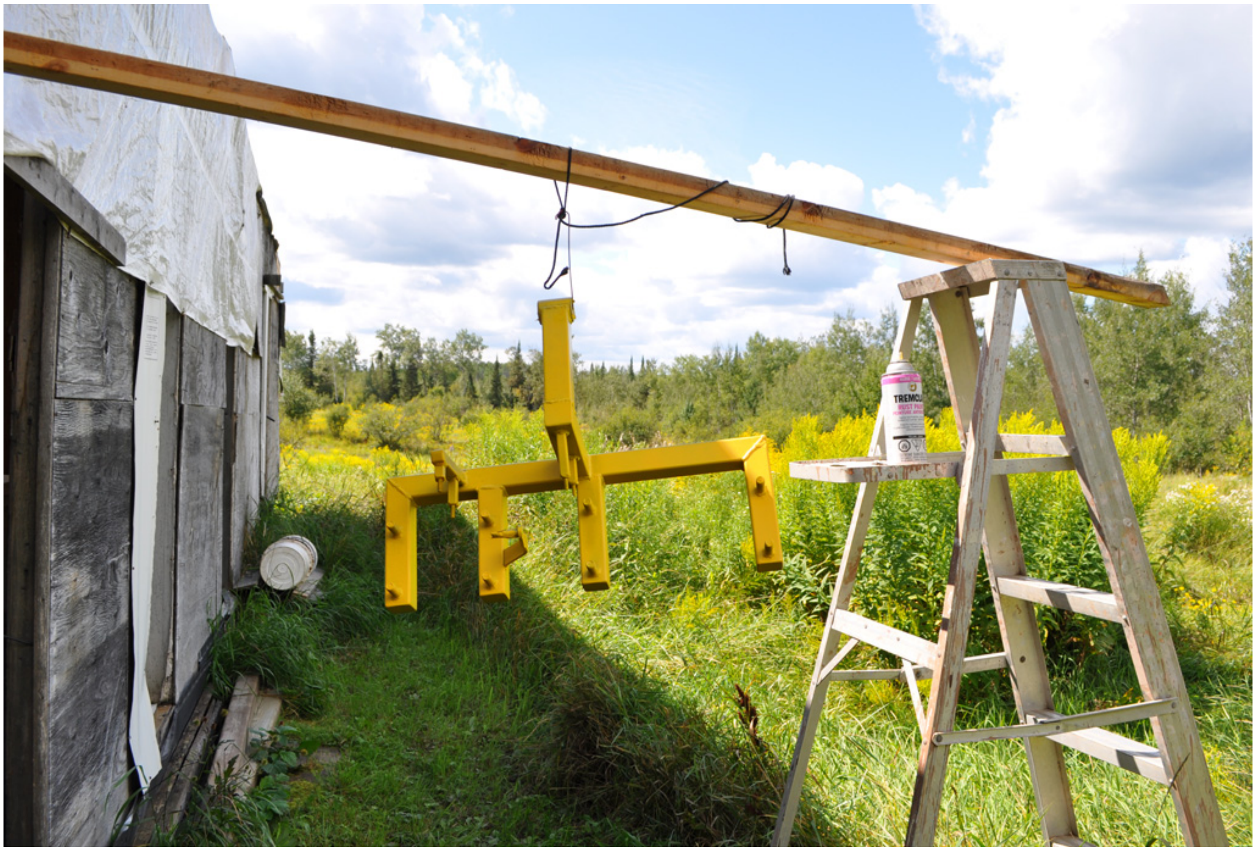


Figure 192 - Painting the Aurora frame parts

My paint jobs usually look as good as a factory job, which is surprising considering that I paint them in the great outdoors using inexpensive hardware store spray paint! I like to paint in the afternoon when there are less bugs to fly into the tacky paint and on a day with a lot of sun to help speed up the drying process. Figure 192 shows my paint shop, which includes an old ladder, a 2x4, and some string. The dilapidated construction trailer on the left is where I build all of my bikes, including this one.

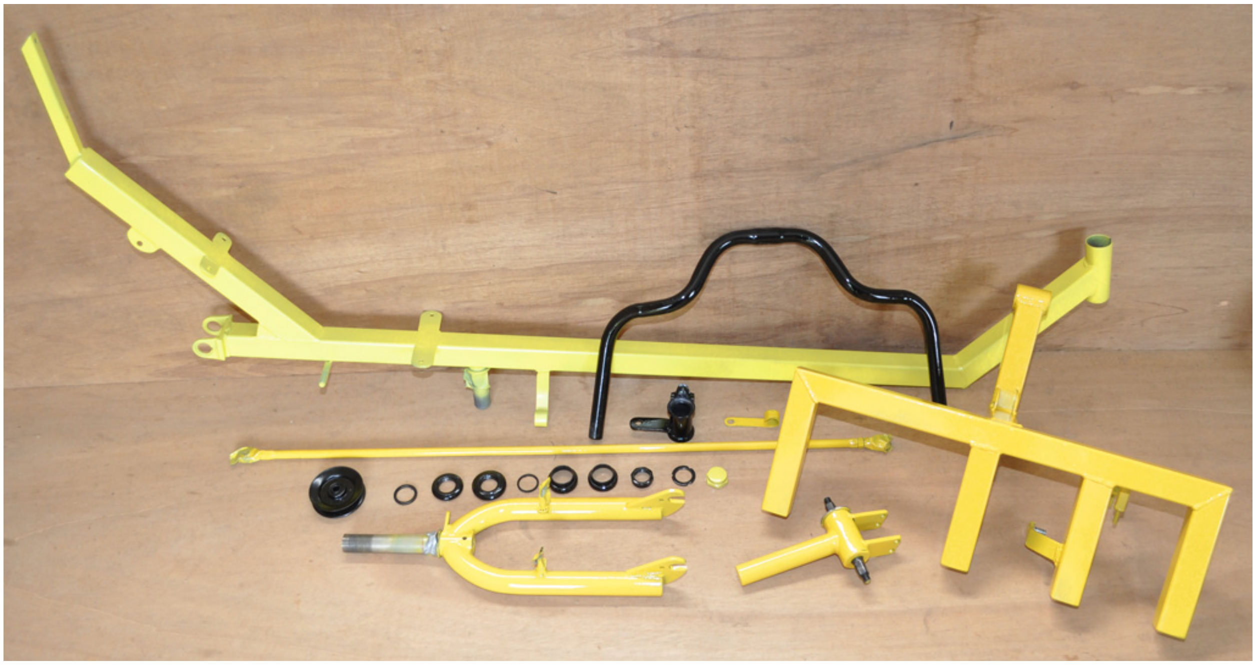


Figure 193 - The painted frame waiting to cure

In honor of my original delta racing trike (the DeltaWolf), I went with the same bright yellow color with gloss black for the trimmings. The paint job turned out really nice, and had cured enough after two days so I could get the trike re-assembled and ready to ride.

ASSEMBLING THE TRIKE

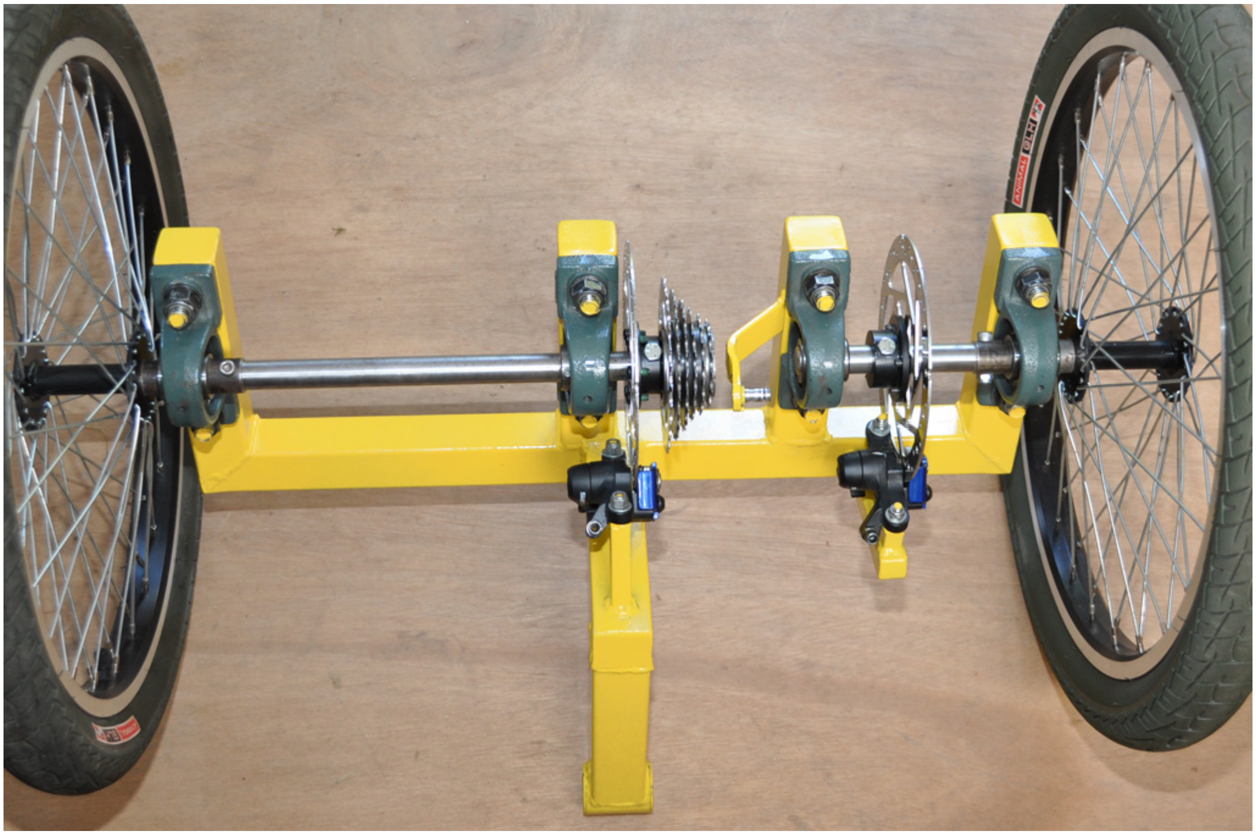


Figure 194 - Assembling the rear frame section

You can put your trike back together in any order you like, but I find it is easier to start with the rear frame section and wheels, as this part will take the most effort. Figure 194 shows the bearings, axles, adapters, and disc brakes installed on the rear frame section. Due to my disc brake mounting position, I had to slide the axles through the bearings after the disc brake hardware was installed on the frame.

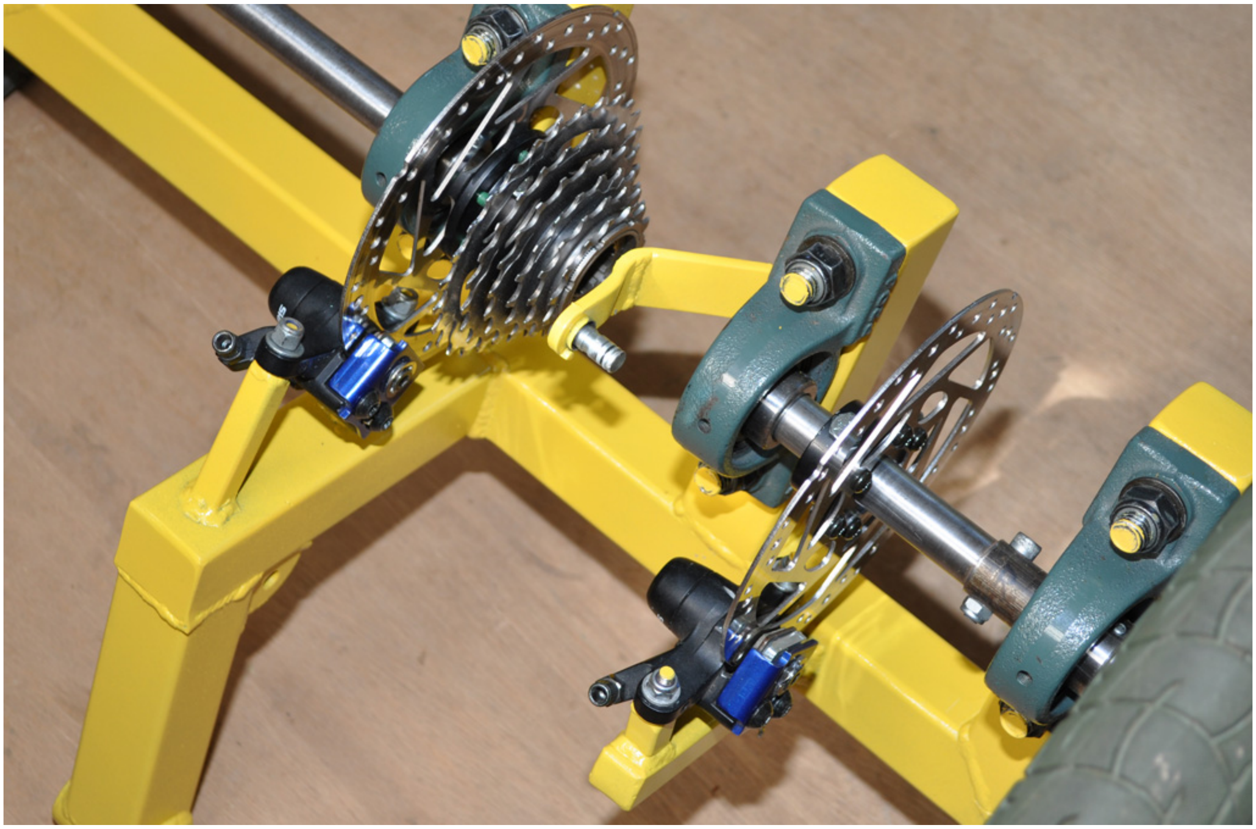


Figure 195 - A close-up view of the rear hardware

This image clearly shows the position of the disc brake hardware and the rear derailleur adapting arm.

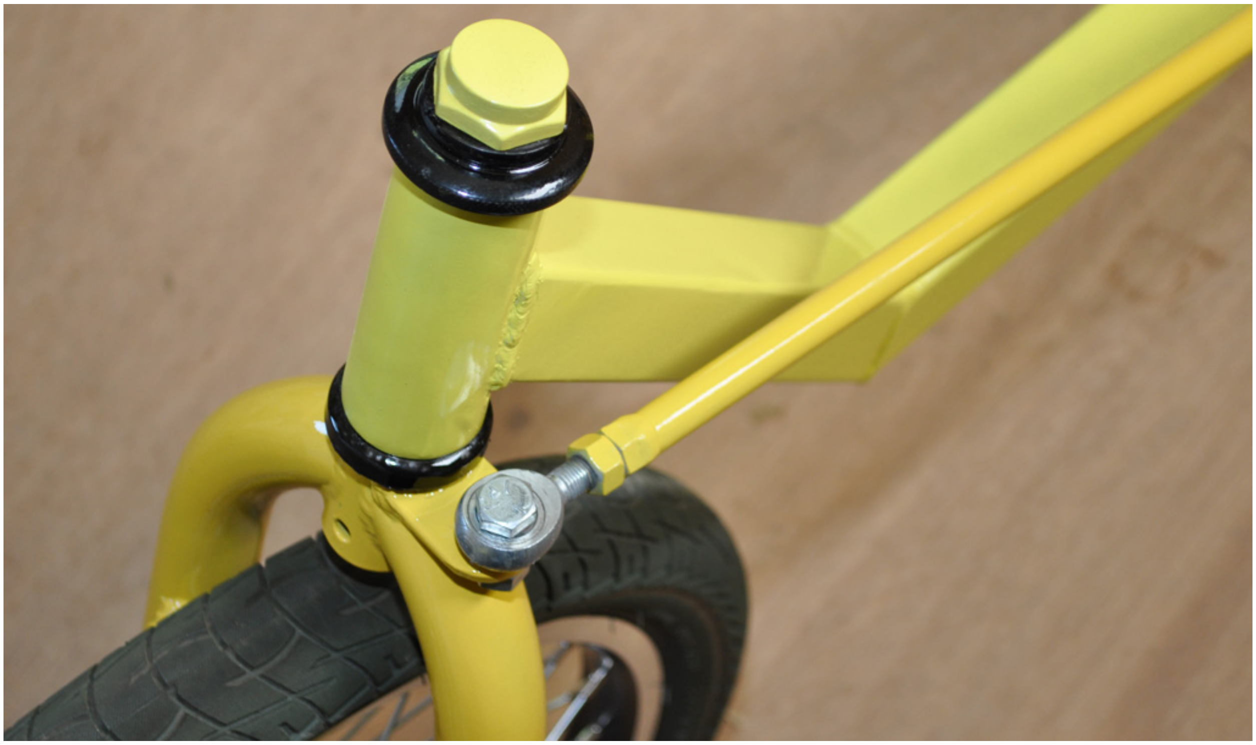


Figure 196 - Installing the steering hardware

Next, I like to install the steering hardware, which includes the front forks, pilot's steering system, handlebars, and steering rod. Clean and re-grease all bearings using hardware store axle grease and put a light coating of grease on the ball joints, working them around to get full coverage.

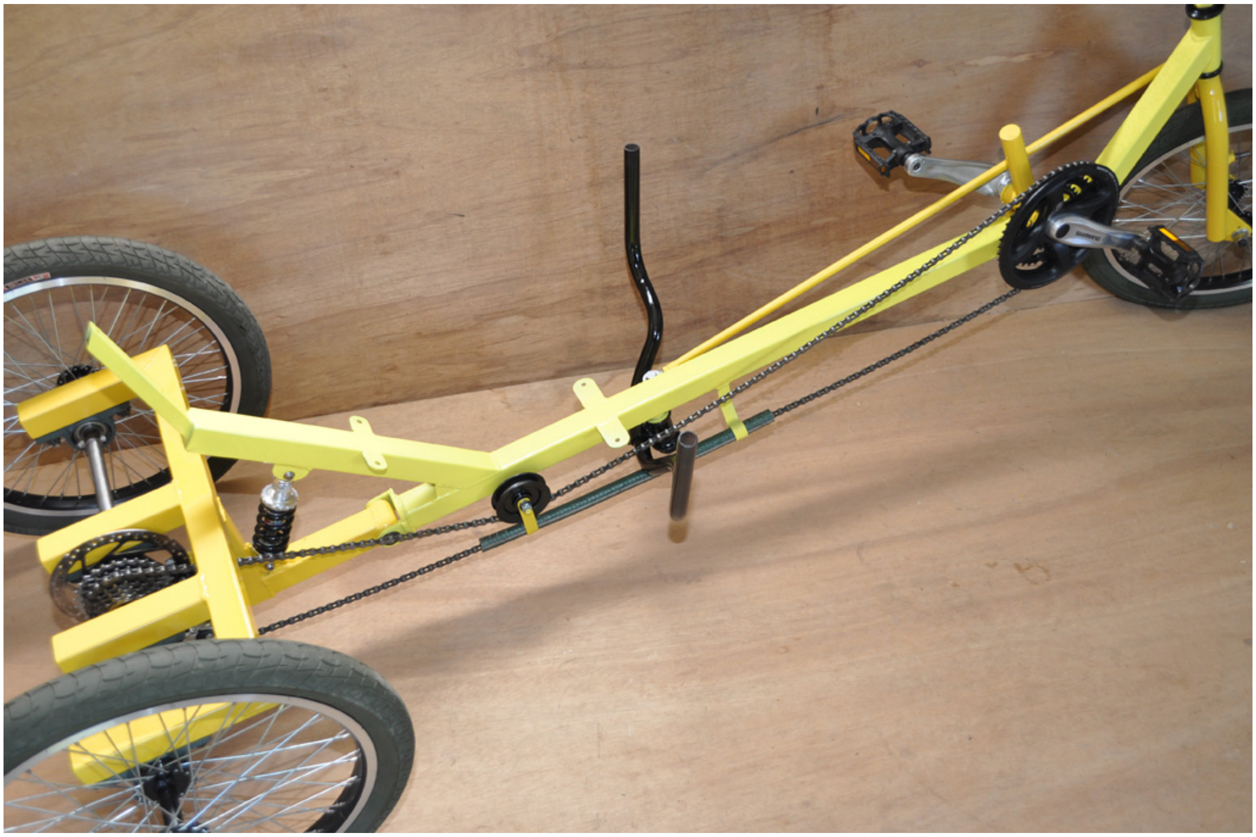


Figure 197 - Chain and cranks installed

The transmission is the last thing to install, including the sliding bottom bracket assembly, idler pulley, guide tube, and chain. I usually give the chain a very light coating of oil from a rag, making sure it is free of any dirt or grit.

ADDING THE CABLES

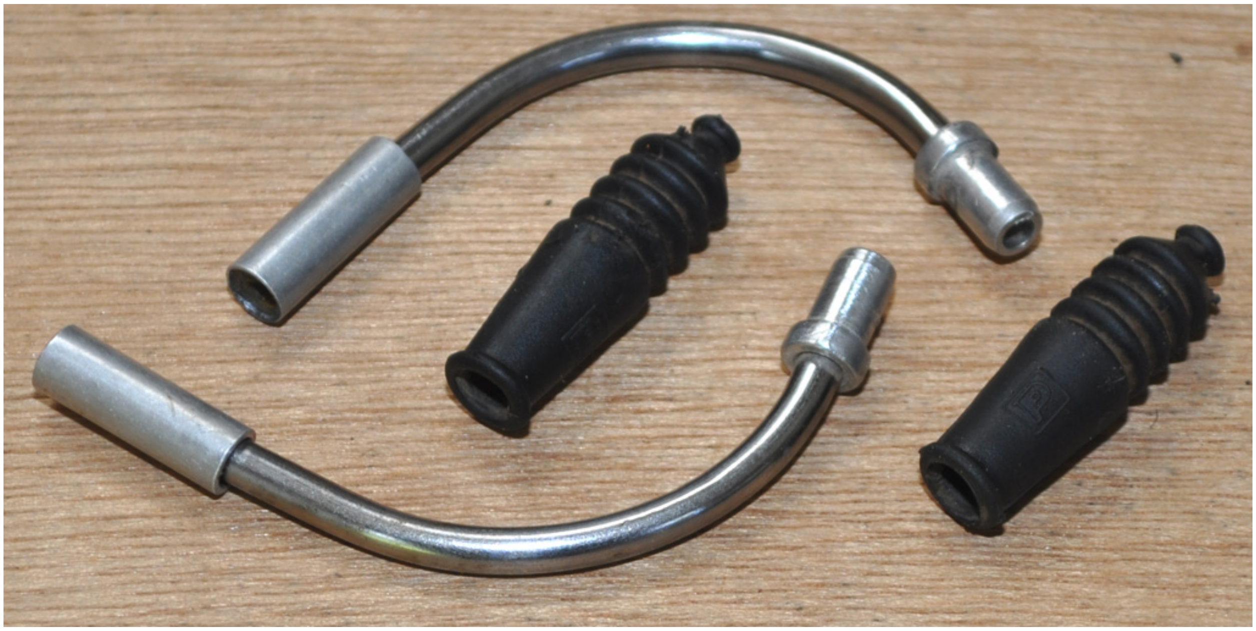


Figure 198 - Cable noodles are a great help

The tiny steel elbows shown in Figure 198 are called cable noodles, and they can make your cabling job much easier, especially when a cable comes out of the hardware in the wrong direction. These elbows will allow a cable to take much tighter 90 degree bend than it could by just forcing it onto a bend. A cable should never be bent into a tight circle as it will create stiffness in the line. I used cable noodles on all three brakes, and they were a great help on the rear disc brakes, which oriented the cables in the exact opposite direction I needed.

✓ Builders Tip

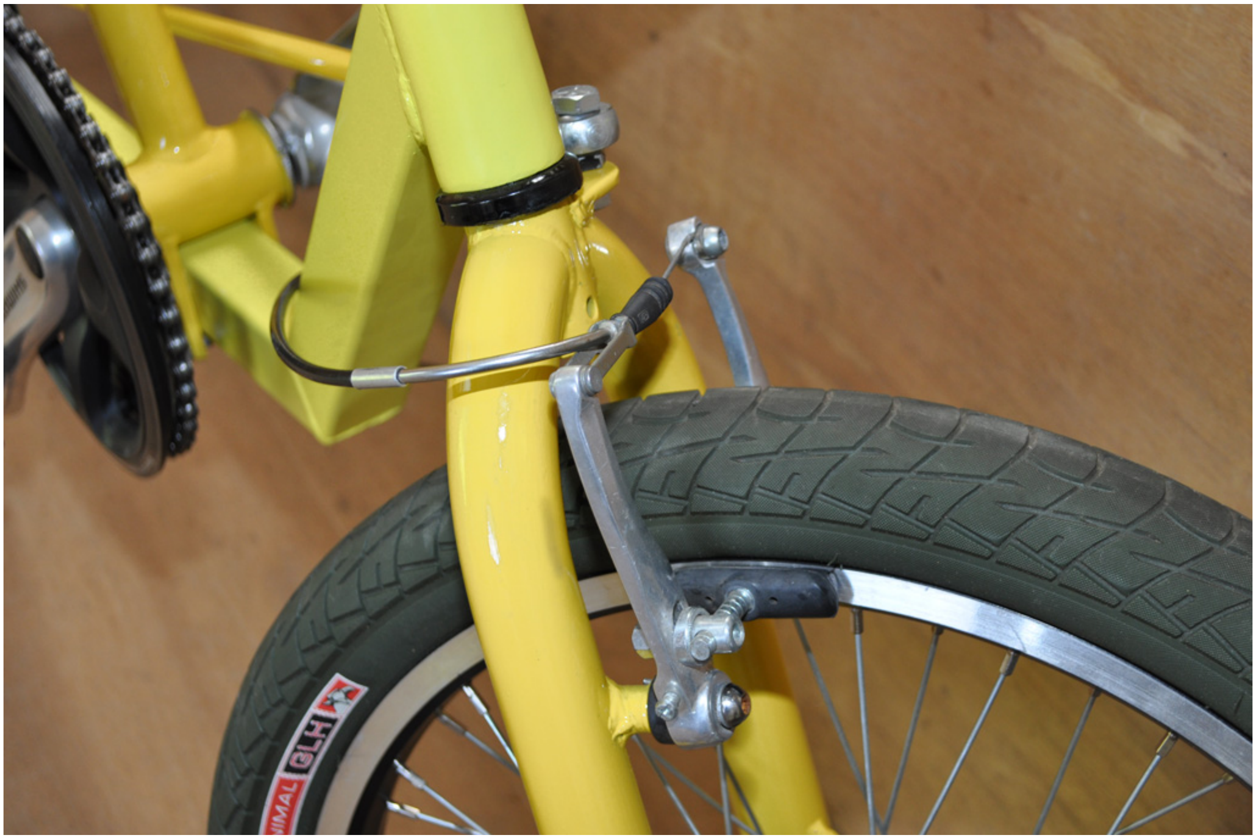


Figure 199 - Installation of the front brake

Figure 199 shows the cable noodle installed on the front brake, allowing the cable to sneak around the front forks with a nice tight bend to help keep it from sticking out too far. The noodles did the same job on the rear brakes, which exited the hardware facing the ground. Setting up the pad brake is quite easy; just ensure that the pad strikes the rim flat as shown in Figure 199 and set it up so that it is away from the rim enough to not rub when the lever is released. There is a small adjuster screw on the cable input to the brake lever that can be used to fine tune the brake tension as you set up the brakes and as they wear over extended use. For more information on brake basics, see the tutorials on the front page of our website.

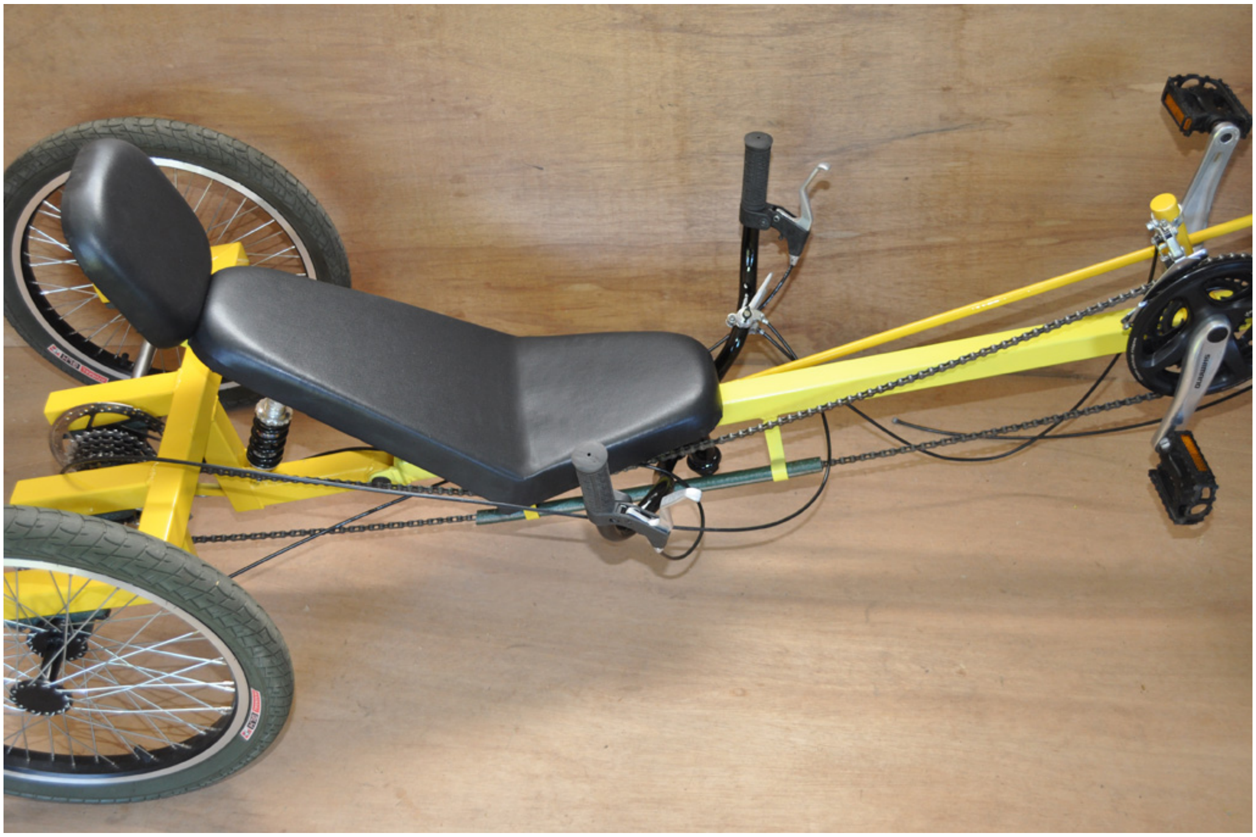


Figure 200 - Laying out the five cables

If you used a front brake like I did, then you now have a total of five cables to deal with. Cables should never be pulled tight or forced to make sharp bends, even when steering is maxed in either direction. If your budget permits, purchase all new cables, rather than messing around with used ones that may be stiff, as they will cause you trouble later on. Start by laying out all of the cables from the levers and shifters as shown in Figure 200 so you can come up with a decent routing plan.

Brake levers should be placed upwards as shown in Figure 200 so they are easy to operate and not in the way of the steering system. If you have three brakes, then you will need to purchase a dual cable brake lever or a cable splitter to allow both rear brakes to operate from one lever. You can find these at bike shops or by searching on the internet for "dual brake lever".

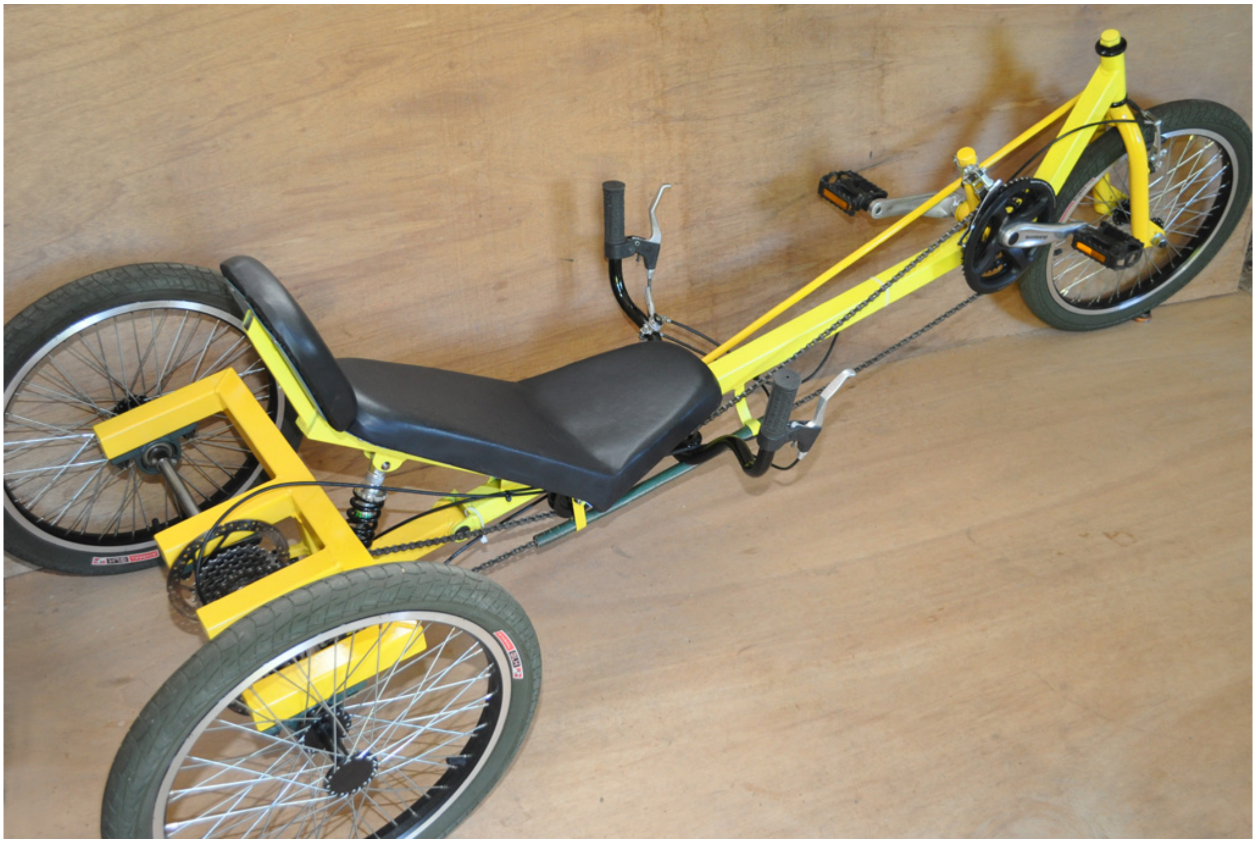


Figure 201 - All cables installed and tied down

Once you have your cables routed in a way that keeps them out of the moving parts, they can be cut to length and tied to the frame using zip ties. To cut a cable, pull away the center line and then cut the sheath with a zip disc. You can then push the center line back through the sheath. Cut the center line to length after it has been installed on the brake or derailleur. Figure 201 shows the Aurora Trike after neatly tying up all of the cables.

Derailleurs require a little more careful adjustment in order to set the minimum and maximum travel through the entire gear range. Both have a minimum and maximum adjustment screws, and these need to be set as you pedal and shift. Place the trike on a bucket so you can pedal the rear wheel and test your gears by shifting them through the entire range. The derailleur adjustment screws are normally found on the side of the body, and if these are not set correctly, the chain will either fail to reach all of the gears, or it will shift right off of the cluster, creating an annoying snag that will force you to stop and dirty your hands while out riding. For more information on adjusting a derailleur, see the tutorials on our website.

✓ Builders Tip

READY TO RIDE!

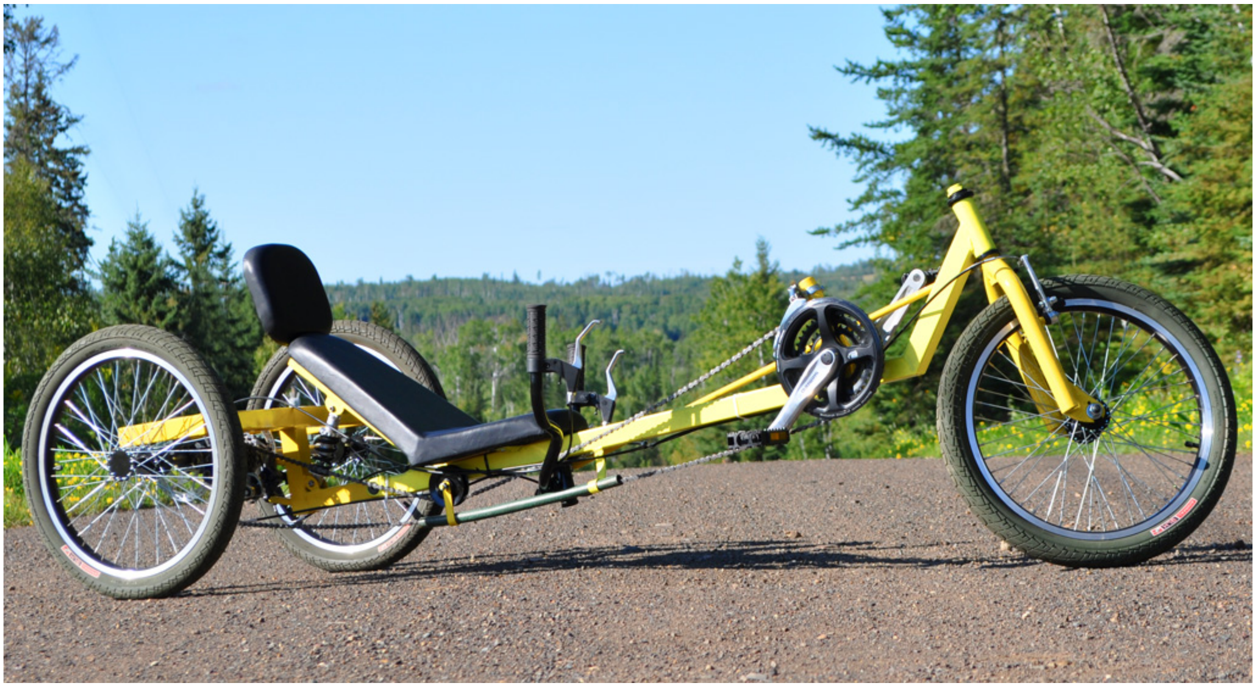


Figure 202 - The completed Aurora Racing Delta Trike.

The completed Aurora Racing Delta Trike is a great looking machine! Since it’s on three wheels, there will be no learning curve involved, so you can just jump into the pilot's seat and hit the open road. Of course, it's a good idea to test your shifters and brakes while you are close to home just in case you need to make some fine adjustments.

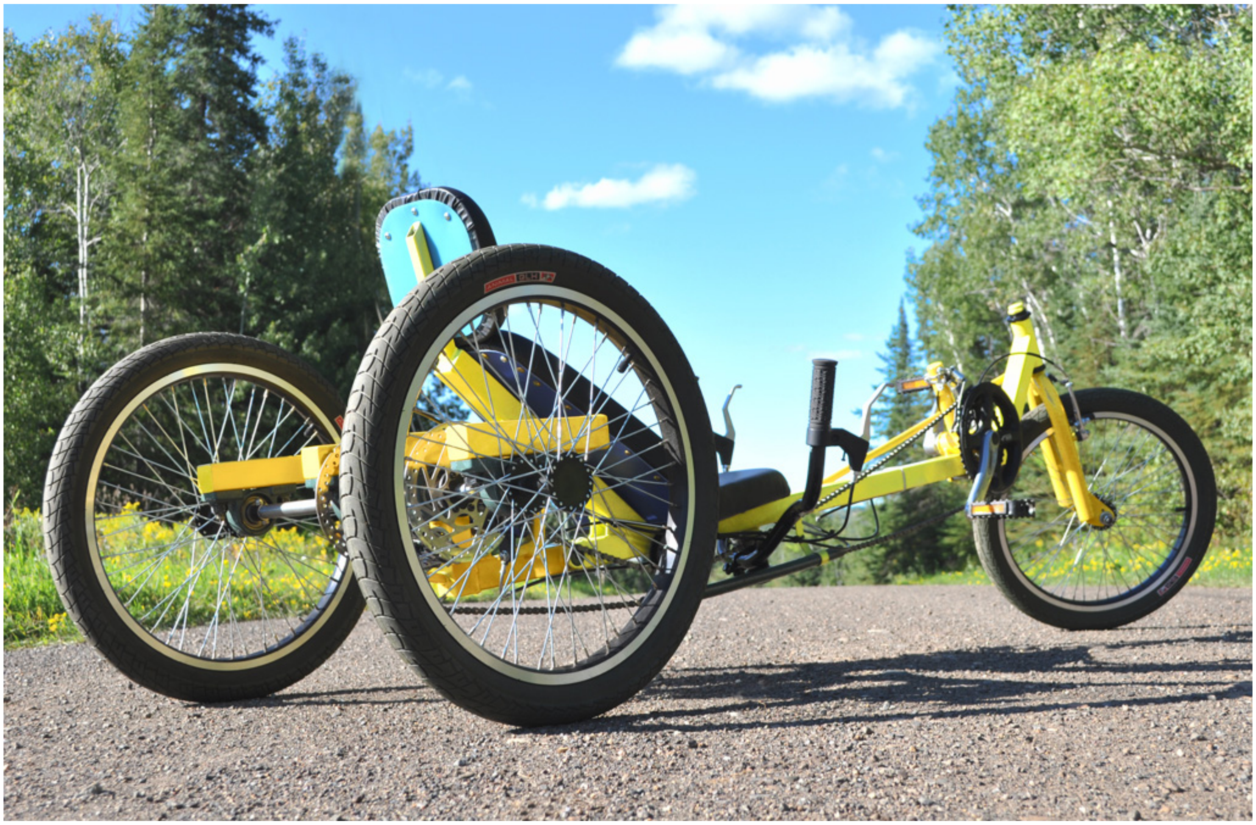


Figure 203 - Cool and laid back, yet ready to race.

There is nothing like the feeling of blasting into a corner at full speed, hugging the ground like a racecar as you keep putting your energy into the cranks. You never have to stop pedaling on a trike. You can just lay back and relax at the next stop light. You will also get an aerodynamic advantage on a very windy day since you are riding with a much smaller frontal area than that of an upright cycle.

As for comfort, it's like cruising in your favorite chair, being able to see the view ahead of you without having to strain your neck to look forward. And, of course, the rear suspension will help take up any shock from rough terrain, making the ride even smoother.

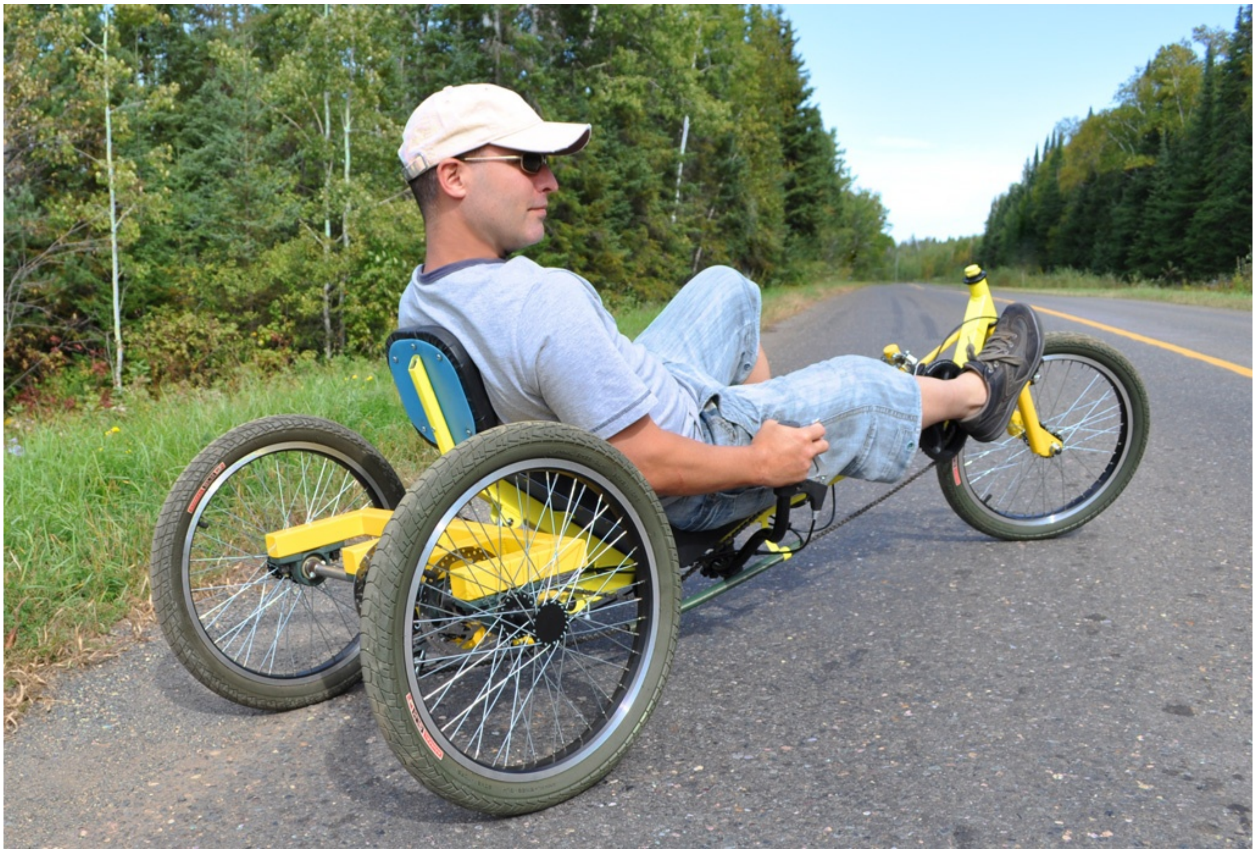


Figure 203 - Final testing of brakes and derailleurs.

Before you set out on a long journey, take your trike around the block, working out the brakes and gears to ensure that your levers and shifters are performing properly. If you can't reach a certain gear or if your chain shifts right off the last gear, then re-adjust your derailleurs by setting the minimum and maximum limit screws once again. Your brakes should respond as soon as you begin to engage the brake levers, but should completely release when they are in the idle position. If your brakes are rubbing all the time or creating friction, then loosen the cable tension by adjusting the cable nuts at the levers or at the brake hardware.

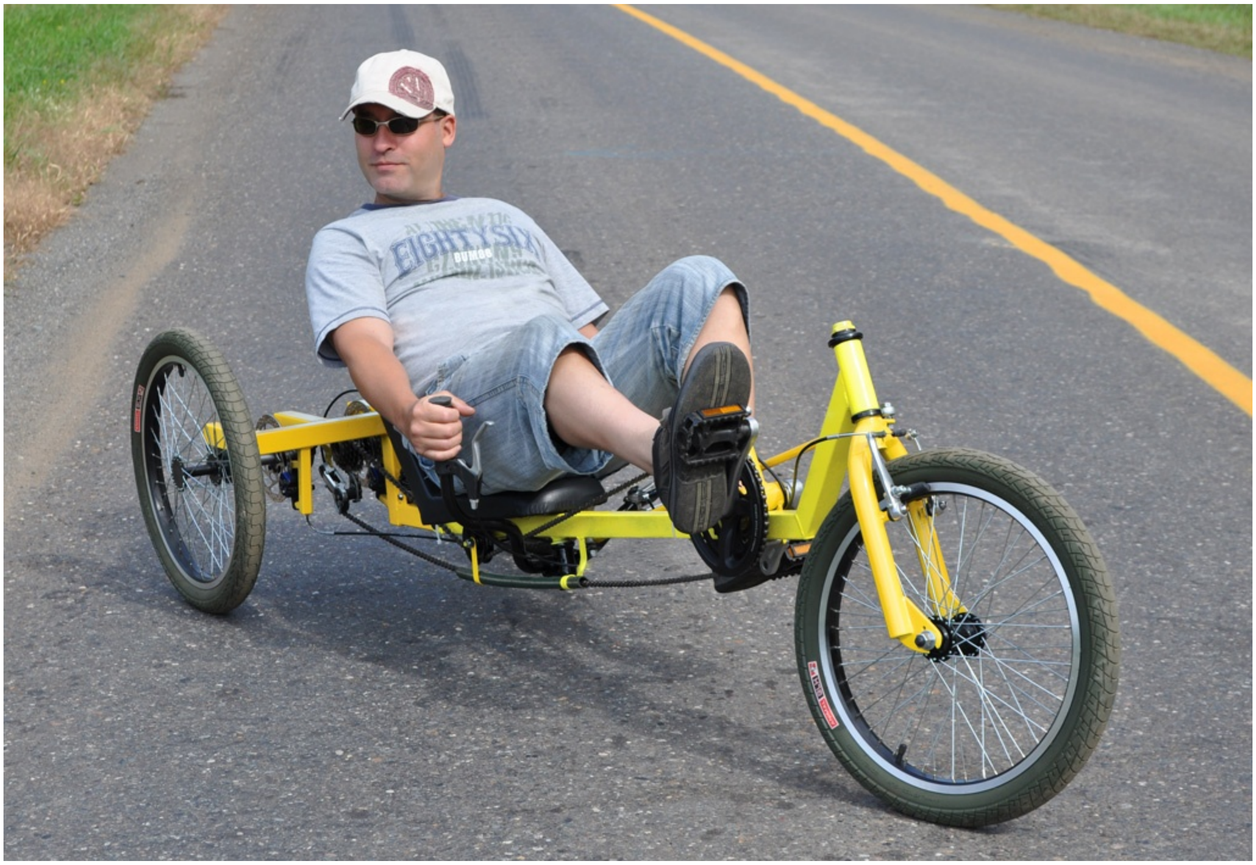


Figure 203 - Testing the limitations around corners.

It's a good idea to learn the limitations of your new trike when it comes to how fast you can take corners and how sharp you can make turns. Get moving at a decent pace and then make sharp turns from left to right so you can feel how your body reacts in the seat. It takes a great amount of effort to get this trike up on two wheels, and you will experience very high G-forces as you crank hard into the corners. You should be able to turn around in about half the width of a regular city road, and will notice that it is more difficult to pedal around a very tight left corner due to the way the left side drive wheel is making a much tighter turning radius. Have fun getting to know how your trike handles before you embark on any serious city traffic dodging or street racing.

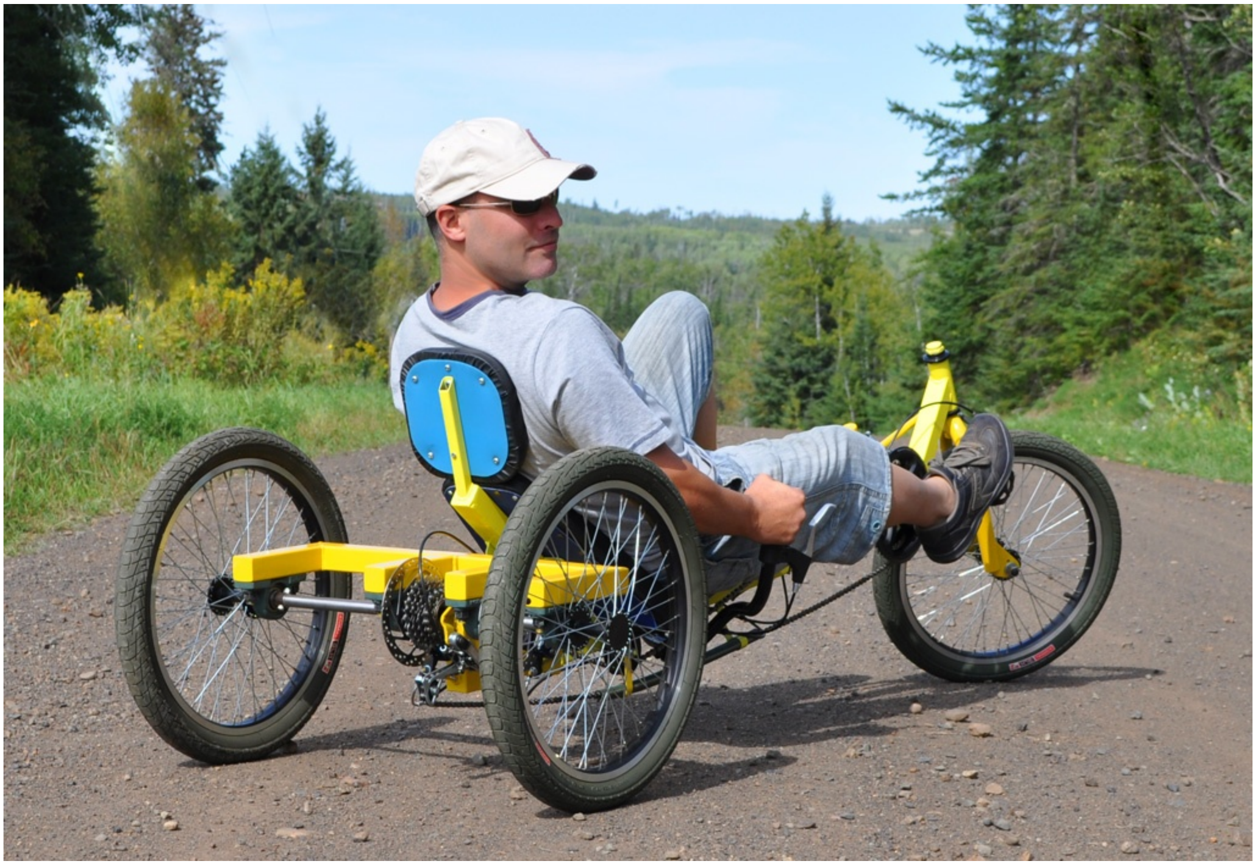


Figure 203 - Testing the suspension on the rugged trail.

The Aurora Delta Trike is quite capable off pavement as well thanks to the rear suspension and very low available gear range. A bumpy gravel road full of ruts is a great place to test your suspension and determine if you need to alter the spring tension for optimal performance. If you find that your trike bounces too much over ruts, then crank the adjusting ring in the clockwise rotation to stiffen up the suspension. You can also make the spring more responsive to smaller bumps by loosening the adjuster ring in the counter-clockwise rotation. Another fun maneuver on loose gravel is to apply only one rear brake and then turn in the same direction as the skidding wheel in order to slide around corners. Of course, this is not the best thing for your tires, but it’s great fun!

Figure 203 - Enjoying the view in comfort and style!

We hope you have many amazing journeys on your new trike, and enjoy the ride as much as you enjoyed building it. If you need any assistance during your build, or just want to show off some of your photos, then please stop by our forum and gallery; we always like to see what others like minded builders are doing. Thanks again for your support, and happy trails!

JOIN THE ATOMIC ZOMBIE KREW

There is plenty of room for modification on this project, so please send us your completed photos for the Builder's Gallery so that others can see what you have done.

If you need any assistance or want advice about an idea, stop by our Support Forum and introduce yourself to our many creative fellow garage hackers.

Good luck on all of your projects. Have fun and ride safely. Brad and Kathy McGowan, Atomic Zombie™ Extreme Machines

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